Draft Environmental Impact Statement on Restricting Sales and Use of Endrin in Montana

THE GREAT SEAL OF THE STATE OF MONTANA
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Montana Department of Agriculture
Helena, Montana

July 1983

Draft Environmental Impact Statement

on

Restricting Sales and Use of Endrin in Montana

MONTANA DEPARTMENT OF AGRICULTURE

Pursuant
to the

MONTANA PESTICIDES ACT

and

MONTANA ENVIRONMENTAL POLICY ACT

July, 1983

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Section I. SUMMARY

In 1982 the Montana Department of Agriculture proposed administrative rules to restrict the use of endrin for controlling cutworms in small grains in Montana (Appendix IV). Pursuant to the Montana Environmental Policy Act, a Preliminary Environmental Review was prepared and certain segments of the proposed rules were determined to have potentially significant environmental impacts. Consequently, it was determined that the restriction of endrin use by rule in Montana should be addressed in an Environmental Impact Statement.

A. Need for Rules to Restrict Endrin

During the spring of 1981 an outbreak of army cutworms in eastern and central Montana resulted in nearly 100,000 acres of small grains being treated with endrin. In early March the Department of Agriculture designed a program to monitor endrin residues in the soil, vegetation, water, and aquatic sediments near treated fields. After errant applications of endrin and toxaphene caused fish kills in Sunday Creek (Custer County), the Department of Fish, Wildlife and Parks was asked to cooperate in the monitoring program to measure affects of endrin applications on fish and wildlife. The Department of Livestock cooperated by analyzing beef tissue and raw milk through their regular statewide monitoring program.

Subsequent analyses during 1981 and 1982 showed endrin residues of varying degrees in nearly all environmental parameters that were sampled. Of concern were endrin residues in game birds that exceeded the action level of 0.3 parts per million (ppm) set by the U.S. Department of Agriculture. As a result the Department of Fish, Wildlife and Parks adjusted waterfowl hunting seasons and issued warnings and instructions concerning the preparation and consumption of waterfowl and upland game birds.

Because of the widespread endrin residues, the possibility for affects to wildlife, the potential for contamination of agricultural products (forage), and potential effects to human health, the Department determined that endrin use should be restricted.

B. Alternatives Considered

This draft EIS considered fourteen alternatives, five of which were rejected from detailed evaluation because of their failure to directly resolve the endrin problem or because of additional adverse economic impacts. The following nine alternatives were evaluated in detail:

Alternative 1: No Action

Alternative 2: Endrin Applied by Commercial Applicators Only

Alternative 3: Buffer Zone Around Private and Public Waters

Alternative 4: Require Commercial or Private Applicators to Complete Training by the Department of Agriculture Prior to Endrin Purchase

Alternative 5: Endrin Applications Restricted to Ground Equipment Only

Alternative 6: Use of Endrin Only Where Economic Infestations Are Confirmed by Trained Individuals to Exceed 1% of a County's Total Planted Small Grains Acreage in a Given Year

Alternative 7: Endrin Application Only After Confirmation of an Economic Infestation by Trained Individuals on a Field by Field Basis

Alternative 8: Limit Endrin Sales in Montana to 5,000 Gallons Per Year

Alternative 9: Suspend Sales and Use of Endrin - Cancel Endrin Registrations When Alternatives Are Registered by the Environmental Protection Agency (Proposed Action)

For additional information on these alternatives refer to Sections III and V of the DEIS.

C. Summary of Environmental Impacts

The Department has determined that the use of endrin according to directions on the EPA-registered label can result in adverse environmental impacts. Terrestrial and aquatic animals occupying grain fields and adjacent areas can be acutely poisoned through direct spraying or consumption of recently treated foliage. Sublethal effects to animals can result from consumption of endrin residues in plants or prey species. These sublethal effects may alter behavior and thus reduce survivability, and cause reproductive problems. The persistence of endrin can result in endrin being transferred through food chains.

EPA has concluded that endrin may be teratogenic to humans with the greatest risk being to female applicators, mixers, or loaders. Exposure can also occur through the consumption of wildlife containing endrin residues. Endrin use can result in residues in game birds that exceed the action levels established by the USDA for poultry.

Continued use of endrin in Montana would necessitate further monitoring for residues in commodities and game animals. Continuation of instructions and warnings to hunters would be

necessary and would probably result in continued reduction in recreational opportunities and hunter expenditures.

In addition to the No Action Alternative (Alternative 1), the Department reviewed 7 other alternatives (Alternatives 2-8) that would restrict but not eliminate endrin use in Montana. While certain adverse environmental impacts were reduced or mitigated, none of these alternatives sufficiently mitigated the potential for the adverse impacts of endrin use. Alternative 9 was chosen to mitigate the adverse environmental impacts resulting from endrin use in Montana.

Several promising chemical alternatives to endrin are now being developed, in particular, chlorpyrifos, fenvalerate, and permethrin. The Department requested and was granted specific exemptions to use chlorpyrifos and permethrin in 1981, 1982, and 1983 for cutworm control in small grains. These chemicals appear to be effective in controlling cutworms, economical for growers to purchase, and do not possess the residual nature of endrin. The possibility for continued exemptions or actual registration of these products will allow the suspension and eventual cancellation of endrin use in Montana (Alternative 9) without economic impacts to small grain farmers.

D. Description of the Proposed Action

The Department of Agriculture proposes to implement administrative rules suspending the sale and use of endrin for control of cutworms in small grains (Appendix V). Existing stocks of endrin may be used in compliance with additional restrictions by certified commercial, government and farm applicators for a period not to exceed two years. Thereafter, any remaining stocks must be disposed of according to EPA and Department of Health and Environmental Sciences statutes on hazardous wastes, or returned to the manufacturer. The additional restrictions would include reporting all intended applications and extending the "buffer zone" restriction to include private bodies of water. Once any of the effective alternative cutworm control chemicals are registered by the Environmental Protection Agency and Montana, the endrin registration for small grains will be cancelled by the Department. The Department is authorized to take this action by the Montana Pesticide Act 80-8-105(3)(a) and 80-8-201(3) MCA. If for some reason, EPA does not register or grant specific exemptions for effective alternative chemicals, then use of endrin would be allowed in compliance with the additional restrictions discussed in this summary and the DEIS. Pesticide dealers would be required to maintain and submit records for endrin sales as required by the Administrative Rules of Montana (Sec. 4.10.504). The cancellation of endrin for grasshoppers in small grains would be continued as enacted by rule 4.10.901 ARM (3/31/82). The endrin registration for vole control in apple orchards will be cancelled immediately.

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U.S. Department of Agriculture - Soil Conservation Service
U.S. Department of Agriculture - Agriculture Stabilization and Conservation Service
U.S. Department of Interior - Fish & Wildlife Service
U.S. Environmental Protection Agency
U.S. Food and Drug Administration

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Montana Department of Livestock
Montana Department of Natural Resources and Conservation
Montana Department of State Lands
Montana Crop and Livestock Reporting Service
Montana State Library

Arizona Game and Fish Department

California Department of Fish and Game

Colorado Department of Agriculture
Colorado Department of Natural Resources - Division of Wildlife

Idaho Department of Agriculture
Idaho Department of Fish and Game

Kansas State Board of Agriculture
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Nebraska Department of Agriculture
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North Dakota Department of Agriculture
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Oklahoma Department of Wildlife Conservation
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Oregon Department of Fish and Wildlife

South Dakota Cooperative Extension Service
South Dakota Department of Agriculture
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Utah Department of Agriculture
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State of Utah, Natural Resources and Energy

Washington Department of Agriculture
Washington Department of Game

Wyoming Department of Agriculture
Wyoming Department of Fish and Game

Other Government

Montana Environmental Quality Council
Montana Legislative Council
Montana State Clearing House

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University of Montana

Provinces:

Agriculture Canada, Research Branch
Alberta Agriculture, Plant Industry Division
Alberta Department of Fish and Game
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Private Groups:

American Agriculture Movement
American Wilderness Alliance
Association of State Grazing Districts
Audubon Society
Council of Cooperatives
Defenders of Wildlife
Ducks Unlimited
Friends of the Earth
League of Women Voters of Montana
Montana Agricultural Business Association
Montana Agricultural Preservation Association
Montana Association of Conservation Districts
Montana Aviation Trades Association
Montana Beekeepers Association
Montana Cattleman Association
Montana Chamber of Commerce
Montana Dairyman's Association
Montana Egg Council
Montana Environmental Information Center - Helena
Montana Farm Bureau Federation
Montana Farmers Union
Montana Grain Growers Association
Montana Pork Producers Council
Montana Rural Area Development Committee
Montana Seedgrowers Association
Montana State Grange
Montana Stockgrowers Association
Montana Wheat Research and Marketing Committee

Private Groups (cont.)

Montana Wilderness Association
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Montana Woolgrowers Association
National Agricultural Chemicals Association
National Farmers Organization
Natural Resource Clinic
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G. The Draft Environmental Impact Statement Was Filed and Made Available to the Public in July, 1983.

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Section II. PURPOSE AND NEED FOR PROPOSED RULES

A. Introduction

Endrin is a chlorinated hydrocarbon insecticide/rodenticide used in U.S. agriculture since 1951. In Montana, during the spring of 1981, an outbreak of army cutworm, Euxoa auxilaris Grote, required the treatment with endrin of nearly 100,000 acres of small grains. Sampling conducted by the Montana Departments of Agriculture and Fish, Wildlife, and Parks measured the rate of degradation of endrin residues in the environment and revealed contamination of several nontarget parameters, namely, fish and wildlife species, plants, soils, streams, ponds and aquatic sediments. Governmental, scientific and public concern over the significance of residues and their potential hazard to humans through the consumption of contaminated wildlife led the Department of Fish, Wildlife and Parks to adjust waterfowl hunting seasons and issue warnings to hunters and consumers concerning the dressing, cooking and consumption of waterfowl and upland game birds. Concurrently, the Department of Agriculture considered restricting the future use of endrin in Montana.

Proposed administrative rules restricting the use of endrin in Montana were developed during early 1982. As required by the Montana Environmental Policy Act, the proposed rules were analyzed under the Preliminary Environmental Review process. This review indicated that some of the proposed rules could significantly impact some environmental parameters. The portions of the rules not having significant adverse environmental impacts were adopted in March 1982, and the remaining rules were withheld pending the preparation of an Environmental Impact Statement (EIS) (Appendices IV and V).

The purpose of this draft EIS is to address the potential restriction of endrin by administrative rules and to assess the impact of these rules on all pertinent environmental parameters.

B. Characteristics and Uses of Endrin

Endrin is classified as a cyclodiene epoxide chlorinated hydrocarbon exhibiting insecticidal and rodenticidal properties. Endrin is an epoxide of the parent compound isodrin and is a stereoisomer of dieldrin. Other chemicals in the cyclodiene class include aldrin, dieldrin, heptachlor and chlordane. Endrin has the empirical formula $C12\ H8\ C16\ 0$ and is alternately named hexachloro-epoxy-octahydro-endo,endo-dimethanonaphthalene.

Endrin was developed by the Velsicol Chemical Company and introduced on the U.S. market in 1951. In the mid 1950's endrin was used on a variety of crops including alfalfa, eggplant, lettuce, potatoes, peppers, tomatoes, strawberries, corn, sorghum, sugar beets, cotton and small grains. The principal use

of the product was insect control on cotton in the southeastern U.S. through the 1960's.

Endrin was first recommended for use in Montana in about 1954 (121) for control of army and pale western cutworms attacking small grains. Later uses included control of grasshopper infestations on small grains, alfalfa, other crops and rangeland.

Endrin, like other compounds in the cyclodiene class, is a non-polar chemical with low water solubility and low vapor pressure. It is highly soluble in fats and is strongly adsorbed to soils and organic materials. Endrin differs from its cyclodiene cousins by having a much smaller partition coefficient (the tendency to distribute between polar and non-polar substrates) which acts to limit its rate of deposition and retention in other organisms. For this reason endrin does not appear to bioaccumulate or biomagnify to the same degree as other chlorinated compounds. Unlike dieldrin, endrin is more reactive to chemical and photochemical forces, a characteristic which acts to further reduce its environmental persistence. This lower degree of persistence as compared to other chlorinated hydrocarbons is evidenced by the fact that endrin is only rarely detected in standard food, water, wildlife and human tissue screenings (177). However, a market basket survey by Johnson et. al. (87) conducted in 10 U.S. cities during 1975 comparing chemical residues in infant and toddler foodstuffs detected endrin in 2 of 10 infant composites and 1 of 10 toddler composites at levels ranging from a trace to 0.011 parts per million. Other chlorinated hydrocarbons such as dieldrin, DDT, and heptachlor were found at greater frequencies.

While endrin appears to represent a lesser persistent hazard to the environment than many chlorinated hydrocarbons, it is the most acutely toxic member of the group. Endrin has an oral LD_{50} for rats of 7.5-17.5 mg/kg, about 12 times more toxic orally than DDT (23). There are several organophosphate and carbamate insecticides of equal or greater toxicity than endrin, however, they are much shorter lived in the environment. It is this unique combination of acute toxicity and persistence that accounts for endrin's environmental hazard.

A number of factors such as soil type, temperature, moisture, organic material, and application rate effect the rate of endrin residue degradation in the soil. Under field conditions, volatilization and photochemical processes play a significant role in the disappearance of endrin from the soil (64). Gowda and Sethunathan (67) demonstrated that endrin breakdown occurred more rapidly under flooded anaerobic conditions than aerobic or aerobic/anaerobic conditions. Matsumara et. al. (93) showed that 25 to 150 different soil microbe isolates actively degraded endrin. There were seven endrin metabolites identified including 12-keto endrin, a toxic metabolite often isolated from rodents.

While some studies involving the repeated application of endrin to soils at extreme application rates have shown endrin to persist in excess of six years, these studies hardly reflect the field use conditions in small grain production areas of the Great Plains. Studies by Bosio and Latil (18) and Elgar and Marrow (49) demonstrated that, when applied at agricultural rates, endrin had a mean half life of 3 to 8 weeks in soil. Edwards (48) reported that the average half life of endrin is greater than two years at annual applications of 1-3 lbs. per acre and that, in general, endrin was more persistent than aldrin, heptachlor, chlordane, or lindane. In Montana, residues in soils of winter wheat fields had degraded 59% by 12 weeks after application but were still present 1 year after application (application rates of 0.2-0.25 lb./acre) (8, 9). Gowda and Sethunathan (67) studied the rate of endrin disappearance from flooded rice paddy soils and found that endrin residues had degraded rapidly within 55 days from from pokkali, alluvial and laterite soils but more slowly from loam, clay loam and sandy loam soils. In the soils of eastern Montana which are commonly loamy types, endrin residues will probably be detectable at low levels (less than 0.1 ppm) for over 1 year after application (8, 9).

Carey et. al. (25, 26, 27) reported the results of the National Soils Monitoring Program conducted in 1971 and 1972. Screening of soils from rice growing areas of the United States for various pesticides revealed endrin in 1 (1.1%) of 99 samples at a residue level of less than 0.01 parts per million (ppm). A similar screening of urban soils from five U.S. cities detected endrin in 1 of 380 (0.3%) samples at a level of 0.17 ppm. A more extensive screening of agricultural soils in 37 states found endrin in 10 of 1,483 (0.7%) samples analyzed for organochlorine compounds with a range in concentration of 0.01 - 2.13 ppm.

There are little data on endrin degradation in water. Endrin is only slightly soluble in water and is rapidly adsorbed to suspended particles. Once adsorbed to particulates, endrin may settle to the sediment-water interface in standing waters or be kept in suspension in moving waters. Sharom et. al. (139) found endrin to be one of the most stable organochlorine compounds tested in water, with 80% of the initial 2 ppm still present after 16 weeks. Under field conditions, endrin disappears from the water column rapidly but tends to concentrate in the bottom sediments (8). Under laboratory closed system analysis endrin degradation in water is slow.

Volatilization and photochemical processes are important factors influencing endrin residue breakdown from plant surfaces and plant tissues. Harrison et. al. (74) studied the disappearance of endrin from apple foliage and found that only 13% of the initial deposit remained after 1 week and 2% remained after 7 weeks. Sampling of endrin treated winter wheat foliage 6 weeks after treatment showed that residues had declined by 99.9% from those measured on the day of treatment (9), however, endrin at

low levels (mean 0.012 ppm) was detected in straw one year after treatment (8).

A screening of crops and soils conducted in 37 states during 1972 detected endrin residues in 7 of 28 standing crop samples (25). Of 858 samples of seven crops analyzed, endrin was positive in 27 (3%) at a range of levels between 0.01 - 0.15 (cotton stalks) ppm. Because EPA has cancelled some crop uses, endrin residues may have declined since this survey was conducted.

Endrin is generally considered to be non-systemic in plants yet several studies have documented the ability of plants to take up endrin residues from contaminated soils. Saha and McDonald (130) reported the uptake of endrin residues from soil by spring wheat only at levels of 2 and 8 pounds active ingredient per acre. Harris and Sans (71) reported endrin uptake by carrots and corn from sandy loam soils and by oats, potatoes, carrots and sugar beet roots in muck soils. No residues were measured in spring wheat at treatment levels less than 2 pounds active ingredient per acre. Wheeler et. al. (174) reported endrin uptake by turnips and soybeans.

A number of studies have reported on the metabolism of endrin in domestic animals and rodents (128, 10, 13, 80, 123, 11, and others). One of the by-products of endrin metabolism in rodents is 12-keto endrin, a by-product more toxic than endrin. Production of this metabolite has not been observed in animals other than rodents. Animals receiving low dietary levels generally store, metabolize and excrete endrin and reach a steady state condition. This steady state level varies between animals species with some exhibiting little tolerance for the chemical. Once removed from the source of contamination, metabolization continues in most species with endrin levels falling below detectable levels at varying time intervals. Residues may be transmitted from mother to offspring in some animals, either in utero or through milk.

In mammals there is no evidence of long term endrin storage in any tissue or organ other than fat. Terriere et. al. (154) measured the endrin content of body tissues of steers, lambs and hogs receiving 0.1, 0.25, 0.75, and 2.00 ppm of endrin in their diet for 12 weeks. All animals gained weight equivalent to the control animals and remained in apparent good health through the study. While small amounts of endrin (less than 0.1 ppm) were deposited in tissues at all feeding levels, fat levels at the 0.75 ppm feeding level ranged from 0.1 ppm in hogs to 0.4 ppm in steers at the end of 12 weeks. After 6 weeks on "clean" feed, residue levels dropped by 60% in the steers and to below detectable levels in lambs and hogs. In a similar study with dairy cattle, Kiigemagi et. al. (88) found secretion of endrin in the milk within 1 week of exposure to the endrin laced diet. At the high feeding rate of 2 ppm, residues disappeared from milk within 1 month of removal from the diet. A residue plateau level in milk was reached at 1 month after introduction to the diet and

maximum body fat residues did not exceed 1 ppm. It was suggested that the ratio of fat storage of endrin versus intake concentration was about 1 to 2 for cattle compared to 15 to 1 in rats. Baldwin et. al. (11) traced carbon 14 labeled endrin in lactating cows fed 0.1 mg/kg of endrin in the diet for 21 days. Milk residues ranged from 0.003 - 0.006 mg/kg; muscle residues 0.001 - 0.002 mg/kg and fat residues 0.1 mg/kg. Ely et. al. (50) fed endrin contaminated hay (1.9 - 3.7 ppm) to milk cows for 48-63 days and determined that a daily intake of endrin greater than 20 mg as a residue on hay was necessary for excretion of measurable amounts of endrin in the milk (0.05 ppm detection level). Williams and Mills (176) found endrin in the milk of cows at 0.5, 0.15, and 0.3 ppm in the diet. Street et. al. (141) found endrin residues in ewes fed 0.75 and 2 ppm endrin in the diet for 12 weeks. Lambs, whose only source of contamination was their mothers milk also showed endrin residues. Residue levels were lower in animals held for an additional 6 weeks on endrin free diets.

Avian species, in general, absorb endrin from the gut and store it in various organs or tissues including liver, brain, breast muscle, and gonads but fat tissue has the greatest storage potential. Terriere et. al. (155) conducted a feeding study with domestic poultry to measure endrin residues in body tissues and eggs. Chickens received diets containing 0.1, 0.25, 0.75, and 2.25 ppm endrin for 6-8 weeks. Weight gain, egg production, and feed consumption were not altered by the presence of the chemical in the diet. It was found that a residue level of 0.1 ppm could be consumed by poultry for eight weeks without contamination of eggs occurring. Residue deposition in eggs occurred at 0.25 ppm and above and detectable levels remained 1 month after cessation of endrin consumption. Contamination of meat tissue occurred at dietary levels of 0.25 and 0.75 ppm and levels were detectable after cooking. Concentration factors of 2X to 5X were recorded in poultry body fat. Studies by Cummings et. al. (39, 40) and Baldwin (11) further confirmed the deposition of dietary endrin in body tissues and eggs of poultry.

At least 4 cases of accidental human poisonings by endrin have been documented (75). In each of these cases, the victims consumed bread made from contaminated flour. In one case it was determined that the bread containing 150 ppm endrin resulted in illness and convulsions of the victims. Back calculations by toxicologists determined that 0.2 mg/kg of endrin had actually caused the illness (144). While it remains the view of the Environmental Protection Agency that available chronic test data for rats and dogs does not conclusively demonstrate a level of risk to humans, an ADI for humans of 0.0002 mg/kg has been adopted based largely on these data (168). According to the EPA, under these guidelines, a 60 kg (132 lb) human could consume 0.012 mg/kg of endrin per day for the rest of his or her life without suffering adverse affects related to endrin.

The risk of mutagenicity and teratogenicity in humans resulting from endrin contamination has been investigated. Studies conducted by the U.S. Food and Drug Administration, the National Cancer Institute, the University of Cincinnati and the University of Miami were reviewed by the EPA's Carcinogen Assessment Group. It was concluded that ".... the weight of evidence is that endrin is unlikely to be a human carcinogen" (3). While this conclusion has been questioned by Reuber (127), the World Health Organization has stated that endrin is not on any cancer list (144). Chernoff et. al. (28, 29) demonstrated that endrin is teratogenic and fetotoxic in rodents. From these studies the EPA concluded that a reasonable risk of teratogenicity in humans exists, with the greatest risk being to female applicators, mixers, or loaders (see labels, Appendix I).

Numerous studies described the acute and chronic effects of endrin to nontarget wildlife and aquatic organisms. In aquatic systems, endrin residues can be concentrated in the sediments. Residues in water and sediments have been shown to significantly reduce the primary production of phytoplankton in freshwater ponds (114). Agrawal (1) demonstrated that endrin in water at concentrations varying from 0.009 ppm to 0.0015 ppm was toxic to four species of freshwater gastropods. The author stressed the need to use endrin with great care to avoid water contamination. Anderson and Defoe (5) documented bioaccumulation and behavioral changes in caddis flies and stoneflies. Stoneflies were shown to concentrate residues by a rate of 610 to 1,023 times that in the surrounding water. Endrin at the concentration of 0.02 Mole/liter affects the development of sea urchin embryos (19). Lamberts (91) showed that exposure to 2 ppm endrin for 24 hours produced significant stress on sea corals.

The toxicity of endrin to fish has been well documented. The LC_{50} of endrin to rainbow trout is about 0.0018 ppm. Because fish have the ability to concentrate endrin residues from water and particulates, relatively small amounts of the chemical may cause significant fish mortality. In fact, fish kills attributed to endrin have been documented (168, 172). Bioconcentration factors of endrin residues by fish can range from 3700X for the bullhead to over 15,000X for the flagfish (5, 7, 78). The half life of endrin in the channel catfish has been measured to be between 6-12 days (7, 81). Sundershan and Khan (153) followed the biotransformation of endrin in the bluegill and found 40% of the test concentration was excreted in 3 weeks.

Endrin has been shown to be extremely toxic to several bird species (76, 67, 73, 44). Tucker and Crabtree (157) listed an acute lethal dose of 5.64 mg/kg to mallard ducks; however the 30 day lethal dose was 0.125 mg/kg/day demonstrating that successive sublethal doses have a cumulative lethal effect. DeWitt (44) reported that 50 ppm endrin in the diet was lethal to adult quail after 5 days and that concentrations of 2-10 ppm were toxic in 22 to 36 days. Brain residues of 0.8 ppm and above are indicative of death due to endrin poisoning (146). Feeding studies with

mallards have shown that, like domestic poultry, endrin is excreted and residue levels greatly reduced within 1 month of removal from the endrin diet (77). It has been observed that quail, pheasants, and mallards can metabolize endrin efficiently enough to survive for 1-2 years on a diet of 1 ppm. Mallards may be able to handle relatively large amounts of endrin in the diet which may explain the low frequency of confirmed mallard kills due to endrin under field conditions (131).

Kreitzer (90) found that bobwhite quail fed endrin at concentrations below those known to be toxic suffered behavioral abnormalities; in particular, the ability to react to novel stimuli. This kind of reaction to endrin may reduce survivability under field conditions. DeWitt (45) found that 10 ppm endrin in the diet of pheasants during the reproductive period significantly reduced egg production and hatching.

Endrin is highly toxic to mammalian wildlife that are exposed dermally, or to dietary residues, or by inhalation. The LD_{50} to mule deer is 6.3 to 12.5 mg/kg; to the pine mouse, 2.6 mg/kg (122); to rabbits, 5-10 mg/kg (157); and to the big brown bat, 5-8 mg/kg (92). Sublethal doses of endrin may result in damage to organs, behavioral abnormalities, metabolic changes, and reproductive disorders (46). Snyder (142) reported that 0.6 pounds of endrin per acre reduced litters in meadow voles.

Despite the toxic nature of endrin to wildlife species, relatively little data are available demonstrating acute mortality to wildlife resulting from endrin applications to agricultural crops. McEwen et. al. (98) reported a significant reduction in numbers of song birds 2-7 weeks following treatment of wheat for pale western cutworm. The authors also reported mortality in four species of mammals, jack rabbits being particularly sensitive. Endrin has been implicated in the death and reduction of brown pelicans, white pelicans, bald eagles, golden eagles and various hawk species (73, 126, 16).

Screening surveys of endrin residues in upland game birds and waterfowl show varying chronic levels of contamination. Greichus et. al. (68) analyzed fat from 46 sharptail grouse and 48 pheasants in South Dakota and did not detect endrin at levels exceeding 0.05 ppm. Zorb et. al. (179) analyzed 72 pheasants collected from Michigan counties. Pooled results from the two counties showed average endrin residues ranging from 0.0032-0.0064 ppm in breast muscle. Blevins (15) conducted a screening of upland game birds in Tennessee in 1978 and found endrin in breast and thigh muscle of grouse, quail and woodcock at ranges of 0.35-1.85 ppm.

Organochlorine insecticides in duck wings are routinely analyzed by the U.S. Fish and Wildlife Service to provide long term trends on residue levels (99). Endrin residues in ducks have generally been lower in the western flyways than in the eastern flyways (Table 1).

Table 1. Percent of Mallard Wing Pools with Endrin Residues.

Year Of Collection	Percent Occurrence by Flyway			
	Atlantic	Mississippi	Central	Pacific
1976-77	5(20)[1]	4(69)	2(56)	0(50)
1979-80	3(29)	8(64)	0(54)	0(44)
1981-82	3(31)	1(78)	0(69)	0(40)

[1] Number in parenthesis is the number of pools analyzed. Each pool consists of 25 wings.

Two mallard wing pools were analyzed from Montana in 1981. In this small sample no endrin was detected although other chlorinated hydrocarbons were. This sampling technique may not have been sensitive enough to detect any increase in the contamination of ducks resulting from endrin use in Montana in 1981. In migratory animals, endrin residues detected probably represent a composite of endrin gathered from various locations along migration routes and at nesting sites.

By the early 1960's serious concern over the environmental safety of endrin arose due to massive fish kills in the lower Mississippi River. The verification of additional endrin related mortality to nontarget organisms and endangered species led the U.S. Department of Agriculture to cancel the use of endrin on alfalfa, eggplant, lettuce, peppers, tomatoes and strawberries (158). In 1971 the Environmental Protection Agency cancelled the uses of endrin on corn, potatoes, sorghum, and sugar beets (167). By the mid-1970's, the chief uses of endrin were insect control on cotton and small grains, rodent control in orchards, pest bird reduction and treatment of forest tree seed. In 1981 there were 122 products containing endrin offered for sale by 58 registrants (171). Currently, there are three products containing endrin registered in the state of Montana (98). One product is registered for army cutworm and pale western cutworm control on small grains only. A second product is registered for army and pale western cutworm control on small grains and rodent reduction in apple orchards. The third product is registered for the reduction of nuisance birds.

Prompted by concern for the potential adverse effects of endrin to human health, nontarget organisms and endangered species, the EPA began an intensive review of the compound in the early 1970's. Endrin was formally addressed by the agency's Rebuttable Presumption Against Re-registration (RPAR) process which culminated in the final decision document published in the Federal Register on July 25, 1979 (167). As a result of this review, all uses of endrin were cancelled with the exception of:

(1) cotton west of Interstate 35; (2) small grains in all states for control of army and pale western cutworms; (3) small grains for grasshopper control in Montana only; (4) pine vole and meadow vole control in apple orchards; (5) minor uses on sugar cane, conifer seeds, alfalfa and clover seeds; and (6) nuisance bird control.

Addressing the human health and environmental impacts of endrin use, the EPA concluded that endrin is unlikely to be a human oncogen nor does it pose a risk of acute dermal toxicity and fatality to endangered species. However EPA further concluded that use of endrin according to label directions could result in a reduction of nontarget organisms, could pose a risk of acute toxicity to wildlife and could pose a risk of teratogenicity to humans. It was felt that restricting the use of endrin to those crops listed above and by requiring certain specific label modifications that these risks could be significantly and adequately reduced. EPA also concluded that the economic benefits of endrin for cutworm control in small grains exceeded the risks.

Presently no tolerances have been established by the EPA that allow measurable endrin residues in agricultural commodities. The tolerances that have been established are "zero tolerances," that is, no detectable endrin is allowable. Commodities that have tolerances established at zero ppm endrin are sugar beets (tubers and tops), broccoli, brussel sprouts, cabbage, cauliflower, cottonseed, cucumbers, eggplant, peppers, potatoes, summer squash, and tomatoes.

A number of action levels, or administrative guidelines, for endrin specify residue levels at which the USDA or FDA may take action to remove commodities from the marketplace. Some pertinent action levels include:

Dairy Products, Milk and Butter	0.3 ppm
Fish, Poultry (fat)	0.3 ppm
Cattle, Swine, Sheep (fat)	0.3 ppm
Eggs	0.3 ppm
Animal Feed (processed)	0.3 ppm

No tolerances or administrative guidelines have been established for small grains, hay or forage.

Regarding its use on small grains, endrin is labeled for control of army and pale western cutworm at the rate of 0.2 - 0.25 lb. active ingredient per acre. The label lists specific criteria for applicators to follow when applying endrin including prohibition of its use within 1/8 mile (buffer zone) of streams, lakes and ponds when applied with ground equipment or within 1/4 mile of lakes, streams, ponds or human habitation when applied by air. No such buffer zone is specified for ponds on private lands; however owners are cautioned that applications within the

specified buffer zones may result in excessive contamination and fish kills.

A specific warning to female workers applying, or handling endrin appears on the label. The label specifically prohibits the application of the product within 45 days of harvest and prohibits the grazing of treated fields or the feeding of treated crops to livestock (see labels, Appendix I).

C. Cutworm Outbreaks in Montana

Cutworms are the larval stage of heavy bodied, night flying moths in the insect Order Lepidoptera, Family Noctuidae. There are over 2,700 species of Noctuidae in the United States and Canada (17). Many of the more than 300 species of Noctuidae common in the Great Plans Region are significant pests of small grains, forage, range grasses and other field crops.

Cutworms are named for their feeding habit of cutting through the stem of a plant at or below the soil surface. This differs from army worms and loopers that generally climb the plant and consume leaf tissue but seldom sever the main stem. Cutworms may be broadly classed as subterranean or surface feeders. The subterranean feeding group spends most of its larval life under the soil surface feeding on the underground portion of host plants while the surface feeding cutworm spends most of the daylight hours under the soil surface, emerging at night or under cloudy conditions to feed on the aerial portions of the plant. There is one cutworm generation per season. Overwintering may occur in the larval, pupal or egg stage depending upon species. The larval stage is the only plant damaging stage. Larvae of most species are active from late April to June.

In Montana, two cutworm species are serious pests of small grains. The army cutworm, *Euxoa auxilaris* Grote, is a surface feeding species and the pale western cutworm, *Agrotis orthogonia* Morrison, is primarily a subterranean species. While small grains are the principle host plants of both species; grasses, alfalfa, clover, vegetable and garden crops are also consumed.

The army cutworm was first recorded in Montana in 1898 as a pest of small grains in the Bitterroot Valley of Western Montana (36). This species overwinters as a partly grown larva in the soil. Activity begins with the first warming trend of early spring. Larvae feed on above ground plant parts but will sometimes consume young plants to just below the soil surface. Feeding occurs primarily early on warm mornings or late in the afternoon and evening. Warm cloudy weather is also a suitable time for larval feeding during daylight hours. Army cutworm feeding continues through the end of May or early June in Montana. The larvae then form pupae in the soil and the adults emerge in June. Adults seek shelter and may even fly to higher elevations to spend the summer. Activity resumes in late August. Mating occurs and egg laying continues through the fall months depending

upon weather. Since the eggs are laid in loose soils it is critical that some moisture is present to prevent desiccation of the eggs. Eggs usually hatch in a matter of days and larvae begin feeding on grasses, weeds, or winter wheat.

The pale western cutworm was first recorded as a pest of Montana crops in 1915 from an area near Brady in Northcentral Montana (117, 118, 30, 31). This species overwinters as a larva within the egg. Hatching begins in mid to late March with peak larval activity in May and June. Damage from this species is usually noticed later than that of the army cutworm. Larvae feed on the underground portions of plants often damaging or destroying the growing point. For this reason, the pale western cutworm is a more damaging species than the army cutworm. Larvae generally remain underground unless moisture forces them to the surface. At the completion of their feeding cycle, pale western cutworm larvae dig three to five inches below the soil surface to form an earthen pupal cell. Much of the summer is spent in this stage with the adults emerging in late August. Mating occurs and eggs are laid in loose soils along ditches or in stubble fields.

Both the army and pale western cutworms occur throughout the semiarid and arid sections of the Great Plains. They have been recorded from the Canadian provinces to Texas and from Oklahoma to Utah. The army cutworm extends east to the Mississippi River and west to Oregon (173). Winter wheat is a preferred host plant for both species and approximately 55% of the 50 million acres of winter wheat grown in the United States is produced within states where these two cutworm species are a continuing potential problem (159). One of these species or both reach economic proportions somewhere within the wheat region each year. It has been estimated that the army cutworm annually infests 690,000 acres of wheat, while the pale western cutworm infests approximately 415,000 acres (169). In Montana, it is estimated that both species annually infest an average of 37,000 acres of the 2,500,000 acres of winter wheat. Untreated, this could result in an annual average loss of about $2,013,000 (159).

The best available source of information concerning past cutworm outbreaks in Montana is the "Report of the State Entomologist", (MSU, Bozeman), first published in 1903. These reports were published annually or biennially through the mid 1970's. They contain information regarding economic insect infestations and control recommendations for each reporting period. A review of these publications provides a historical account of army and pale western cutworms.

The army and pale western cutworms were considered the most significant insect pest of Montana agriculture from the early 1900's to 1920. Between 1901 and 1910, infestations of army cutworms were recorded from Miles City and the Gallatin and Yellowstone Valleys. In 1915 the first widespread army cutworm outbreak occurred and a reported 100,000 acres of small grains were destroyed (36). Severe infestations of pale western

cutworms occurred from 1919-1921 causing extensive crop loss in northern and central Montana. In 1920 the outbreak peaked with an estimated 250,000 acres of grain destroyed throughout Eastern Montana, (117, 30, 31).

Since the early 1900's localized economic infestations have occurred frequently; however, widespread outbreaks exceeding 80,000-100,000 acres are not frequent. Figures 1 and 2 illustrate the counties from which economic infestations of each species have been reported. Army cutworm has been a significant pest of small grains in all but 10 counties while the pale western cutworm has reached economic levels in all but 25 counties. As can be seen from the maps, the pale western cutworm is somewhat restricted to the eastern two-thirds of Montana while the army cutworm has been reported from both sides of the Continental Divide. These maps do not show the entire biological range of each species but only those counties in which they have reached economic levels.

The severity of cutworm infestations in Montana was hard to define from the State Entomologist's reports. Often, specific acreage was not estimated. On four occasions over the past 80 years with the army cutworm and two occasions over the past 68 years with the pale western cutworm, infestations were extensive, including nearly all counties of eastern Montana. In these cases, infested counties were not listed separately in the reports. For the most part, only infestations causing economic damage either on a local, regional or statewide basis were reported. Table 2 lists the chronological order of the economic infestations for each species.

Economic cutworm infestations occur frequently in Montana although not annually. A closer examination of the reported outbreak history shows that economic infestations of the army cutworm have occurred in 38 of the past 80 years or 48% of the time. However, over the past 30 years (1953-1982) there have been 20 economic infestations (67% frequency). The pale western cutworm has reached economic levels in 30 of the past 68 years (44% frequency) and 13 of the last 30 years (43% frequency). Occasionally both species become problems in the same year so that over the past 30 years, one species or the other has reached economic levels in 23 years (77% frequency). In other words, economic cutworm infestations in small grains have occurred in approximately three out of every four years since 1953.

An examination of the cutworm outbreak reports for army cutworm (1903-1982) shows 34 infestations recorded for specific counties with an additional four outbreaks that were widespread and included most of the eastern counties of the state. Comparison of the geographical frequency of occurrence of the 34 outbreaks shows that of the 46 counties reporting army cutworm outbreaks, 3 (7%) had suffered 8-12 outbreaks; 10 counties (22%) had suffered 4-7 outbreaks and 33 counties (72%) had suffered 1-3 outbreaks.

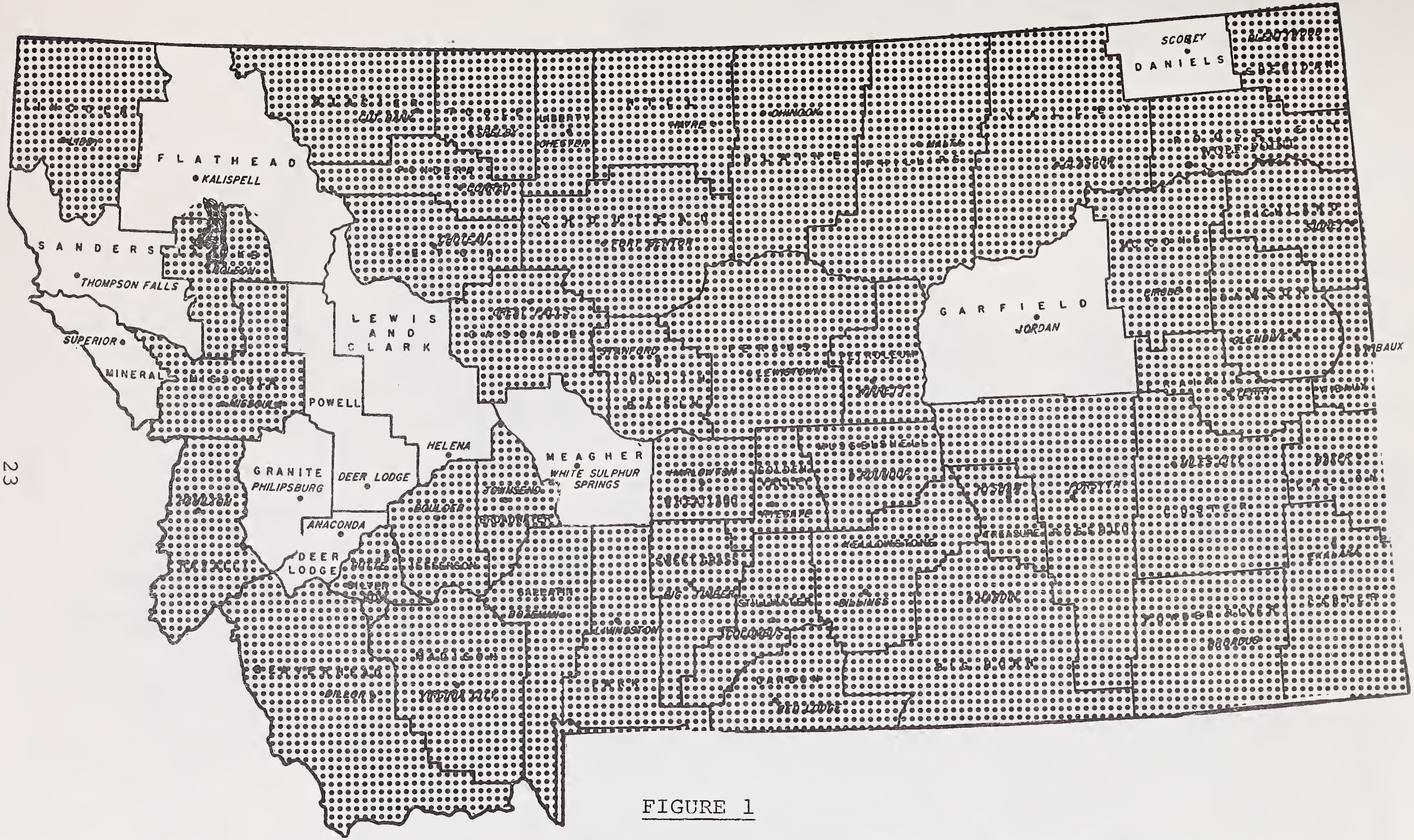


FIGURE 1

Counties from which economic infestations of army cutworms have been reported (1903-1982) in small grains

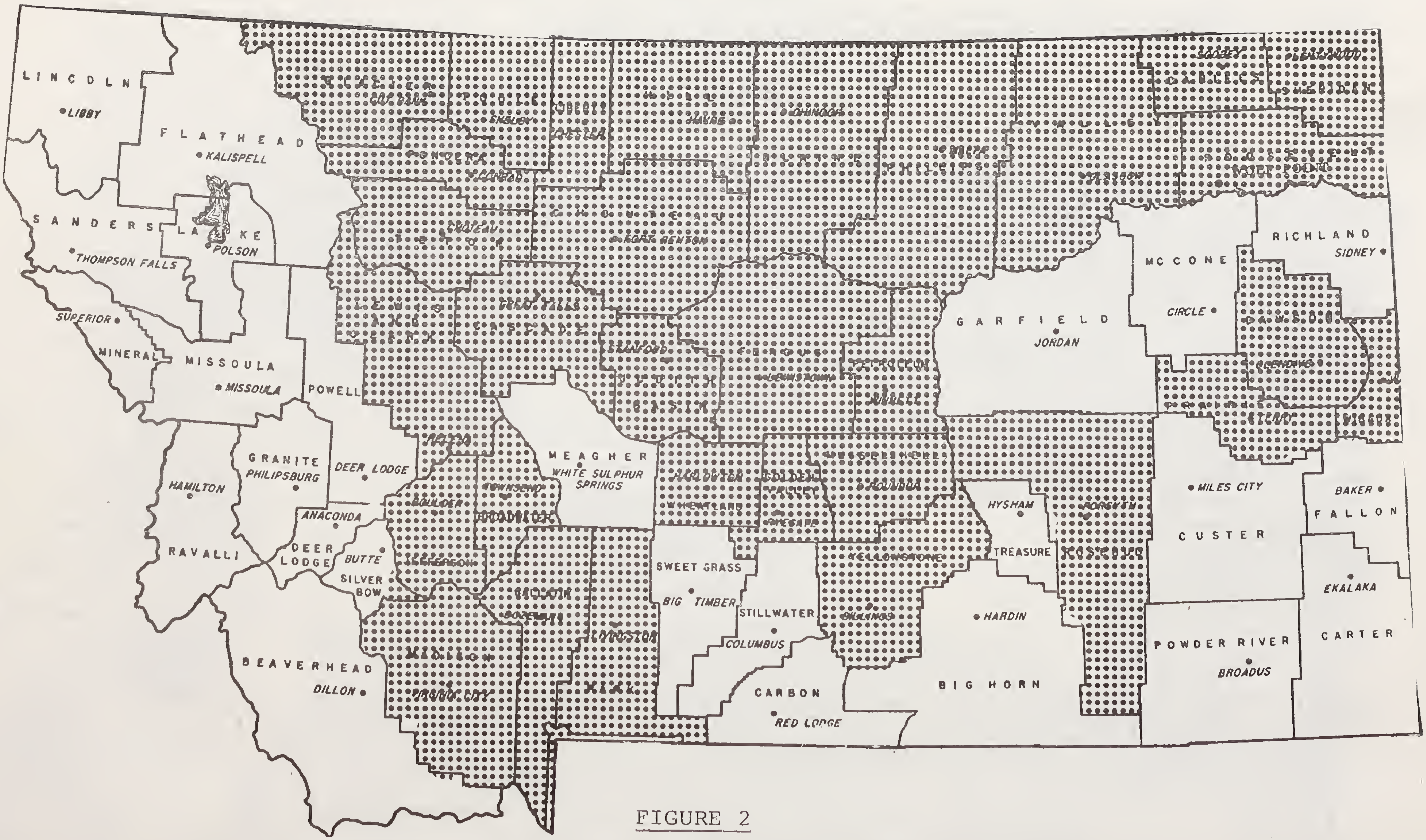


FIGURE 2

Counties from which economic infestations of pale western cutworms have been reported (1915-1982) in small grains

Table 2. Historical Record of Economic Infestations of Army and Pale Western Cutworms in Montana Small Grains*.

Year	Army Cutworm	Pale Western Cutworm
1903	No reported infestation.	
1904	No reported infestation.	
1905	No reported infestation.	
1906	Gallatin Co. - 4,562 acres.	
1907	No reported infestation.	
1908	No reported infestation.	
1909	No reported infestation.	
1910	No reported infestation.	
1911	Scattered light.	
1912	No reported infestation.	
1913	No reported infestation.	
1914	Widespread - Eastern counties.	
1915	Widespread - Eastern counties - 100,000 acres.	First record; light near Brady (Pondera County).
1916	No reported infestation.	No reported infestation.
1917	Light, scattered.	Extensive - northern counties.
1918	No significant infestations.	No reported infestations.
1919	No reported infestations.	Widespread 12 counties in north and east, 2 counties in central; $1 million loss; no acreage listed.
1920	No reported infestations.	Widespread losses over 14 counties - Hill, Liberty, Cascade, Jefferson, Broadwater, Chouteau, Phillips, Teton, Pondera, Glacier, Blaine, Judith Basin, Lewis & Clark, Toole - 250,000 acres.

1921	No reported infestations.	Widespread - Broadwater, Cascade, Chouteau, Dawson, Fallon, Glacier, Hill, Jefferson, Liberty, Prairie, Teton, Toole, Yellowstone - Loss 19% of seeded acreage.
1922	Light in Northcentral counties.	Light - Jefferson, Liberty Counties.
1923	No reported infestations.	No reported infestations.
1924	Light - Judith Basin County.	No reported infestations.
1925	No reported infestations.	No reported infestations.
1926	Light - Chouteau County.	Light - Daniels and Sheridan Counties - 1,000 acres.
1927	Report Missing.	Report Missing.
1928	Report Missing.	Report Missing.
1929	No reported infestations.	Light, scattered.
1930	No reported infestations.	Light, scattered.
1931	Light.	No reported infestations.
1932	Widespread - most severe in Southeastern counties: Big Horn Yellowstone; Western counties: Lake, Missoula, Ravalli, Fergus.	Widespread - Valley, Judith Basin, Fergus, Gallatin, Sheridan, Roosevelt, Fallon, Prairie, Rosebud, Teton, Yellowstone, Pondera - 140,000 acres.
1933	No reported infestations.	Widespread - Valley, Fergus, Cascade.
1934	No reported infestations.	No reported infestations.
1935	No reported infestations.	Light, scattered.
1936	No reported infestations.	Widespread - Northern counties.
1937	No reported infestations.	Light, scattered.
1938	No reported infestations.	No reported infestations.
1939	No reported infestations.	No reported infestations.
1940	No reported infestations.	No reported infestations.

1941	No reported infestations.	No reported infestations.
1942	Widespread - Eastern counties.	No reported infestations.
1943	No reported infestations.	No reported infestations.
1944	No reported infestations.	No reported infestations.
1945	Widespread - Chouteau, Judith Basin, Fergus, Petroleum. Wheatland, Golden Valley, Musselshell, Treasure, Yellowstone, Stillwater, Carbon, Big Horn - 300,000 acres.	No reported infestations.
1946	Widespread - Southeastern counties: Powder River, Fallon.	No reported infestations.
1947	Light, scattered Eastern counties.	Light - Cascade, Hill.
1948	Light, scattered Eastern counties.	Light - Cascade, Hill.
1949	No reported infestations.	No reported infestations.
1950	Widespread - Big Horn, Gallatin, Carbon, Stillwater, Fergus, Yellowstone.	Severe in Chouteau County - 50 square miles.
1951	Light - Liberty, Chouteau, Fergus, Judith Basin, Phillips, Prairie.	No reported infestations.
1952	Moderate - Toole, Pondera, Hill, Cascade, Yellowstone.	No reported infestations.
1953	Scattered to moderate - Chouteau, Sheridan, Roosevelt.	No reported infestations.
1954	Widespread and severe; following counties affected: Cascade, Chouteau, Fergus, Musselshell, Golden Valley, Stillwater, Yellowstone, Wibaux, Fallon, Carbon, Gallatin, Jefferson, Madison, Broadwater.	Moderate - Hill, Musselshell Counties.
1955	Light scattered infestations in Northern counties.	Light infestation - Yellowstone, Madison, Gallatin, Pondera.
1956	Scattered infestation - Rosebud, Chouteau.	Widespread and severe - Liberty, Chouteau, Broadwater, Jefferson, Yellowstone, Pondera, Teton, Cascade.

1957	Very abundant - Fergus, Judith Basin, Liberty, Dawson, Yellowstone.	Light - Chouteau.
1958	Light - Liberty.	Light - Fallon, Liberty.
1959	No reported infestation.	No significant infestation.
1960	No reported infestation.	Heavy infestation - Valley, Roosevelt, and neighboring counties, light in Lewis & Clar
1961	Scattered and light - Cascade, Custer.	Heavy - Liberty, Toole; Liberty Light - Yellowstone, Valley, Phillips, Dawson
1962	Scattered and light - Richland, Roosevelt, Chouteau, Cascade.	No significant infestations.
1963	Light - Powder River, Big Horn.	No significant infestations.
1964	Moderate - Park, Carter, Big Horn, Hill, Glacier.	Light - Valley Co. 15,000 Ac.
1965	Severe - Hill, Judith Basin, Yellowstone.	No significant infestations.
1966	Widespread - Lincoln, Big Horn, Dawson, Carbon, Chouteau, Yellowstone.	No significant infestations.
1967	Widespread - Judith Basin, Carbon, Yellowstone, Beaverhead, Sweet Grass, Silver Bow, Jefferson.	No significant infestations.
1968	Widespread and severe - Most counties east of the divide.	Widespread - Wibaux, Lewis & Clark, Yellowstone, Daniels, Teton, Phillips, Pondera, Valley Liberty, Judith Basin, Toole.
1969	Widespread - Carbon, Yellowstone, Big Horn, Hill, Blaine, Phillips, Valley. Est. 80,000 acres.	Light - Toole, Phillips
1970	No reported infestations.	No reported infestations.
1971	Light to Heavy - Cascade, Yellowstone, Broadwater, Chouteau, Hill, Liberty, Broadwater, Sweet Grass, Stillwater, Est. 45,000 acres.	Light, scattered - Cascade, Judith Basin, Lewis & Clark Est. 5,000 acres.

1972	No reported infestations.	No reported infestations.
1973	Heavy - Carter and Northeast counties.	Heavy, Widespread - Eastern counties.
1974	Widespread, heavy - all Eastern counties. Est. 150,000 acres.	Moderate - Heavy - Eastern counties. Est. 30,000 acres.
1975	No reported infestations.	No reported infestations.
1976	No reported infestations.	No reported infestations.
1977	No reported infestations.	No reported infestations.
1978	Light - Moderate - Dawson, Wibaux, Prairie, Fallon.	No reported infestations.
1979	No reported infestations.	No reported infestations.
1980	No reported infestations.	No reported infestations.
1981	Widespread, Heavy - Twenty-seven Eastern, Central, Northern counties: Custer, Fallon, Powder River, Big Horn, Prairie, Carter, Wibaux, Dawson, Richland, McCone, Rosebud, Treasure, Golden Valley, Carbon, Yellowstone, Stillwater, Fergus, Judith Basin, Chouteau, Cascade, Teton, Pondera, Toole, Liberty, Broadwater, Gallatin, Park.	No reported infestations.
1982	No reported infestations.	Heavy - Golden Valley, Light-scattered - Cascade, Lewis & Clark, Teton, Yellowstone, Wheatland. Est. 17,000 acres.

* 1903-1982 Outbreak information summarized from Reports of The State Entomologist, Extension Entomology Specialist and Montana Department of Agriculture files.

Figure 3 illustrates those counties most likely to be involved in future army cutworm outbreaks.

A similar comparison for pale western cutworm shows that, from 1915-1982, 26 outbreaks were reported for specific counties. An additional 2 outbreaks occurred over a widespread portion of the state. Of the 30 counties experiencing pale western cutworm outbreaks, five counties (17%) have suffered 6-7 outbreaks; eight counties (27%) 4-5 outbreaks; 10 counties (33%) 2-3 outbreaks and 7 counties (23%) one outbreak. Figure 4 illustrates those

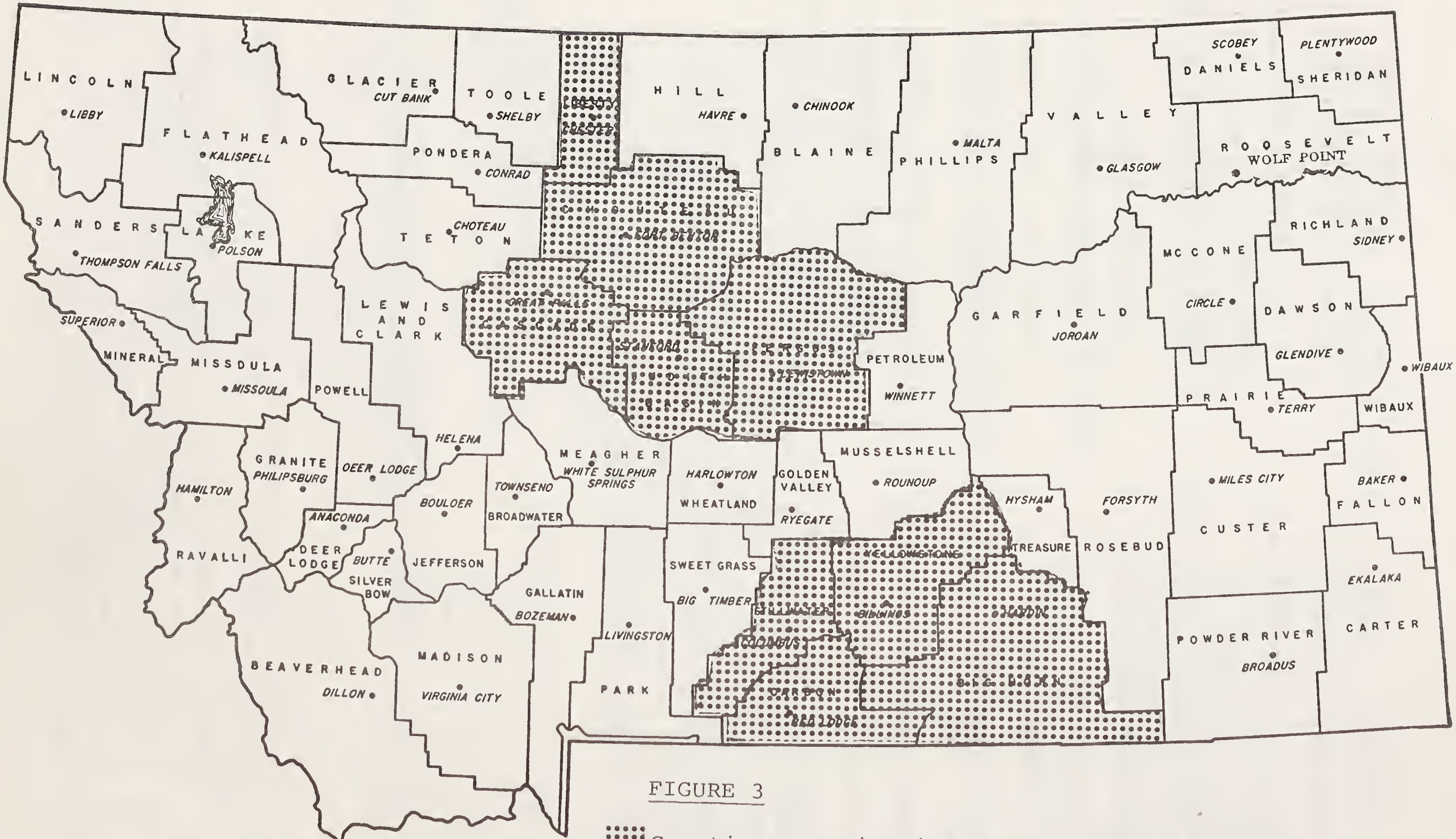


FIGURE 3

Counties experiencing 6 to 12 army cutworm outbreaks, 1903-1982

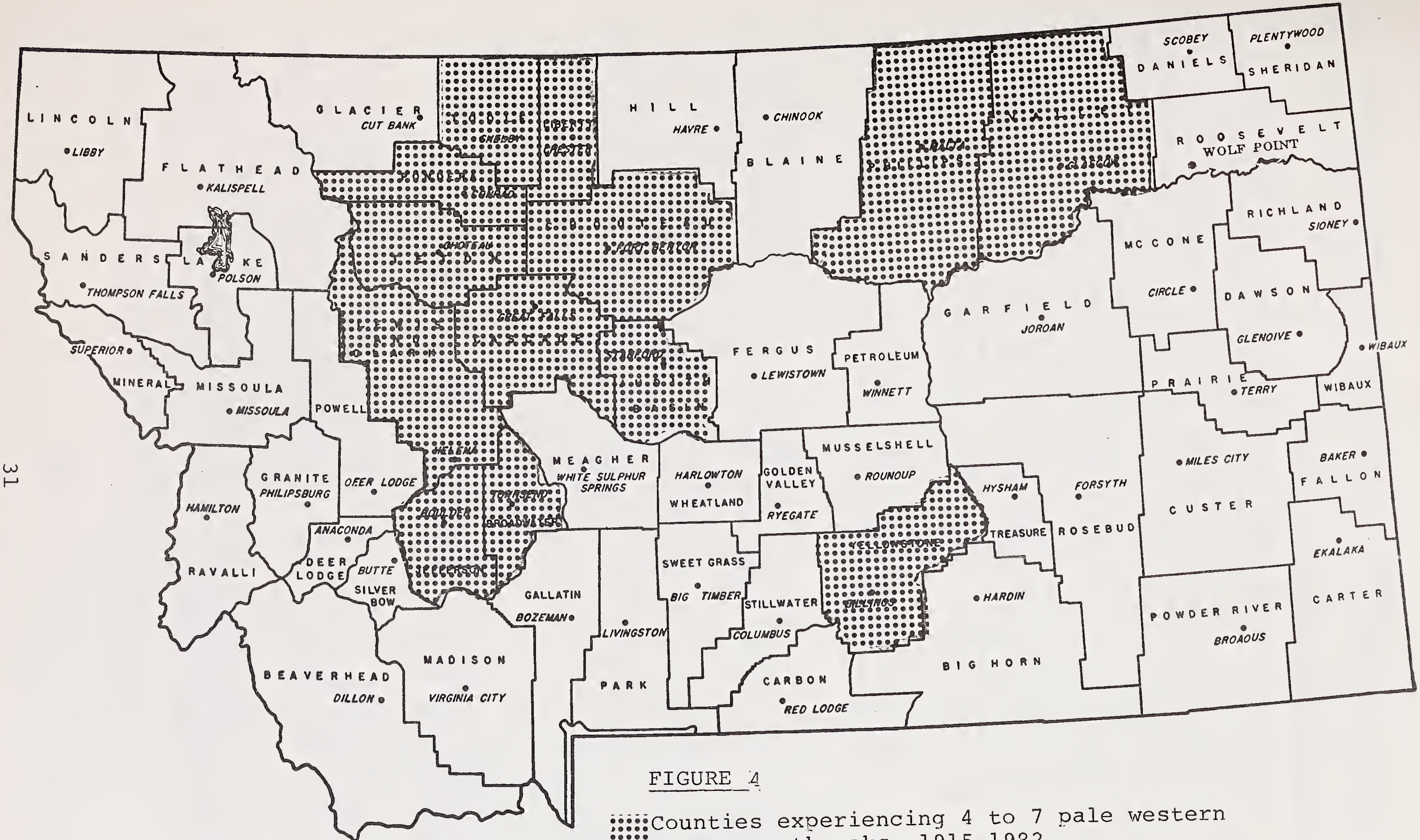


FIGURE 4

Counties experiencing 4 to 7 pale western cutworm outbreaks, 1915-1932

counties experiencing from 4-7 pale western cutworm outbreaks since 1915.

D. Prediction of Cutworm Outbreaks

Since the initial rise of army and pale western cutworms to prominence as major economic pests of small grains, scientists have intently searched for accurate methods of predicting outbreaks. Early farmers associated the attraction of large numbers of moths and "millers" to porch lights at night with the potential for cutworm problems the following spring. Scientists in the early 1900's felt there was a strong relationship between weather conditions and cutworm populations, but it was not until the work of Seamans (132) that a firm correlation was drawn between precipitation during the spring months of one year and cutworm population levels the following spring. Working with pale western cutworms in the Canadian provinces to the north of Montana, he demonstrated that pale western cutworm buildups were preceded by a year with less than 10 "wet days" in May and June, the period of greatest larval activity. A wet day was defined as one in which more than 0.25 inches of rain fell. Seamans felt that wet conditions forced a large percentage of the larvae to the soil surface where they fell victim to parasites and predators.

Cook (30, 31, 32) in Montana expanded on the work of Seamans by measuring total precipitation falling in May, June and July rather than wet days. Cook felt that the increased incidence of disease in larval populations due to wet soil conditions was equally as important as increased parasitism and predation. Therefore he felt that a population increase was preceded by a year with less than 4 inches total rainfall in May, June and July. Cook theorized that pale western cutworm populations could not more than triple in one optimum season so that two consecutive dry years would proceed a large widespread outbreak. By comparing climagraphic information for the Great Plains region, Cook (32, 33) divided Montana into zones in which he predicted the frequency of outbreaks. He predicted that large outbreaks would occur along the east slope of the divide every 16 years, in the central Montana plains every 20-25 years, and in eastern Montana every 30 years with smaller, localized infestations occurring somewhat more frequently.

Seamans (135) later refined his model by stating that less than 10 wet days during the period of pale western cutworm larval activity would result in a population increase; 10-15 wet days would result in little change in numbers, while more than 15 days would result in a decline. Of significance, is that both the approaches of Seamans and Cook were employed successfully in combination with specific cultural practices through the 1930's as the principal management approach for pale western cutworms in the Northern Great Plains.

The relationship between weather and population increase is not as clear for the army cutworm. Seamans (132) proposed a model similar to that for the pale western cutworm. The army cutworm model showed that a population increase was preceeded by a year with less than 1½ inches of rain in July and a mean July temperature of greater than 63 degrees Fahrenheit followed by 4½ inches or more of rain in August, September, and October. The premise of the model was that a dry midsummer was required to insure maximum survival of the adults yet adequate soil moisture during egg laying was critical to prevent egg desiccation and insure maximum hatching and a high survival of hatching larvae. While these conditions in general are optimum for army cutworm development, Cook (33) demonstrated that army cutworm buildups tended to historically occur within a "normal" zone of weather conditions, making prediction considerably more difficult. The army cutworm model was not used as extensively as was the pale western cutworm model due, in part, to the relative ease of controlling army cutworm and the unavailability of adequate pale western cutworm control measures.

Various trapping methods have been used to monitor adult cutworms since the early 1900's. Light traps of several designs are still being used today. The recent discovery of synthetic sex attractants or pheromones has greatly increased the sensitivity of trap monitoring (152). However, even after nearly seventy years of trap monitoring, scientists have yet to draw an accurate correlation between trap catches and expected population levels the following spring. While large flights of adults in the fall usually indicate extensive oviposition, there are a multitude of factors acting upon the egg and larval stages that finally determine whether an outbreak will occur. Refinement of the pheromone trapping system coupled with detailed life history data may enable researchers to advance outbreak prediction.

E. History of Cutworm Control Efforts

Army Cutworms

The army cutworm, because of its tendency to feed on the soil surface, has been much easier to control than the pale western cutworm. Cooley (35) recommended that fallow fields be kept weed free since he felt that moths would not lay their eggs in a clean field or one with a crusty soil surface. Additionally, fields that were suspected to contain army cutworm larvae could be tested in the spring by planting a row or two of bait plants. If these plants were not destroyed by cutworms it was safe to assume that spring grain could be planted.

Early insecticides were limited to gardens and small fields because of the manpower and expense required to treat large plantings. It was discovered early that army cutworm larvae would readily take poison bran scattered on the soil surface. Bran baits and sprays containing Paris green (copper acetoarsenite) or London purple (calcium arsenite and calcium

arsenate) were used successfully on small acreages; however, on large fields, growers had to rely on building trap furrows along the edges of fields to catch migrating army cutworms and prevent them from entering the field.

The Paris green baits were used extensively during the 1915-1916 outbreak. The bait, a mixture of 50 lbs. bran, 1 gallon of molasses, 1½ gallons of water and 1 lb. of Paris green, was scattered at the rate of 20 lbs. to the acre (148). With the substitution of sodium or calcium arsenite for Paris green, this bran bait was a standard army cutworm control method through the 1930's. Sodium fluosilicate was introduced in the late 1930's for grasshopper control and was found equally effective against army cutworm. The sodium fluosilicate bait was used until the mid 1940's when the first synthetic organochlorine insecticides were introduced. By 1951 toxaphene at 2 lb./acre had nearly replaced the baits (120). It was found that the effectiveness of toxaphene was linked to adequate soil moisture and moderate temperatures. Control under dry cool conditions was very erratic. By 1954, endrin at 0.1 - 0.2 lb./acre was found to be superior to toxaphene in Montana (121).

McDonald and Jacobsen (94) tested the relative efficacy of several organochlorine compounds against army cutworms in the laboratory and found endrin to be superior as a contact and stomach poison compared to aldrin, dieldrin, heptachlor and chlordane. Through the 1960's and 1970's endrin, toxaphene and endosulfan (Thiodan) remained the three principal insecticides registered and recommended for control of army cutworms.

Recently, there has been considerable testing of new insecticides for control of army cutworms. McDonald (96) compared the toxicities of 29 compounds using endrin as a standard. He found that endosulfan, chlorpyrifos and methamidophos were 3-4 times less toxic orally than endrin while the synthetic pyrethroids, permethrin and biothanomethrin were 1.2-2 times more toxic than endrin. Chlorpyrifos was shown to be slightly less effective or equal to endrin. The pyrethroids were equal to or superior to endrin as soil insecticides in microplot testing. Fenvalerate, another synthetic pyrethroid, has shown promise for controlling cutworms. Currently, fenvalerate, chlorpyrifos and permethrin are candidates for army cutworm control chemicals.

The army cutworm, like many insect pests, is often held in check by natural enemies. The surface feeding habits of the army cutworm make it vulnerable to a variety of predators, parasites and disease organisms. Strickland (148) presents one of the earlier accounts of natural enemies. Observations and rearings conducted during an extensive outbreak in 1915 in southern Alberta confirmed predation on army cutworm larvae by two species of ground beetles, _Calosoma tepidum_ and _C. zimmermanni_. The black digger wasp, _Ammophila luctuosa_, tiger beetles in the genus _Cicindellid_ and ants (_Formica sanguinea_) also preyed on army cutworm larvae. Avian and mammalian predators included meadow

larks, sparrows and ground squirrels (gophers). Parasitism reported by Strickland accounted for about 28% mortality of army cutworm larvae in 1915. Parasites included Apanteles laeviceps, Meteorus sp., Berecyntus bakeri var., euxoae, Amblytes sp. (all parasitic wasps) and the fly, Phirichaeta sequax. Two unidentified disease microbes reportedly caused considerable larval mortality. Work by Strickland (150) provides life history and host information for these and other cutworm parasites.

Mortality induced by natural enemies, namely parasites and diseases, has often accounted for high percentages of larval mortality in the army cutworm, particularly during the latter stages of outbreaks. While little is known about the influence natural enemies might have in preventing population buildups, their effect is usually too little and too late to prevent crop damage during an outbreak. Augmentation of natural enemies and development of effective biological insecticides may hold promise for the future. At the present time there are no effective biological control agents registered for army cutworm control.

Pale Western Cutworms

Because of its subterranean feeding habits, the pale western cutworm was extremely difficult to control with methods available to farmers in the early 1900's. Many attempts were made to kill the larvae with poison baits similar to those employed against army cutworms (66, 37, 118). Some success was obtained by harrowing or drilling the bran bait into the soil but results were erratic and chemical control of this species was generally considered impossible until the mid 1940's. By 1920 a series of cultural measures had been developed that proved to be somewhat successful in minimizing crop loss to pale western cutworms. Cooley (38) summarized these recommendations: (1) summer fallowed ground plowed early and kept weed free will be less affected, (2) do not work summer fallow July 15 - September 15, (3) spring starvation of larvae is sometimes effective, (4) no cultural practice is effective in winter wheat except to delay planting until after September 15, and (5) early irrigation will prevent damage.

Seamans (136) and Seamans and Rock (137) further studied the concept of starving young larvae in the spring. They found that newly hatched larvae could remain alive in the soil for prolonged periods without food. Yet, if they were allowed to feed for a time and then have their food removed they soon succumbed to cannibalism or starvation. This information was formulated into the recommended practice of allowing 6 to 11 days between spring cultivation and seeding of spring grains. Jacobsen (79) further refined the starvation approach. These cultural methods coupled with the outbreak predictive models of Cook (30, 31, 32, 33) and Seamans (135, 136) formed the principal management plan for pale western cutworm through 1950. This approach served as a moderately successful preventative method but was not effective once an infestation had begun and damage was evident.

The first testing of organochlorine insecticides for pale western cutworm control was by Brown (21). He evaluated 15 compounds in the laboratory and found lindane to be superior followed by chlordane. Toxaphene was not effective. Pyrethrum was the most toxic chemical but was unstable in the field and too expensive. Jacobsen et. al. (83) conducted a series of field tests with chlordane, dieldrin, aldrin, BHC, toxaphene and heptachlor. They found dieldrin and chlordane most effective. Hoerner (79) tested several organochlorine compounds and compared their effectiveness when applied as a soil surface spray and when soil incorporated. TDE, dieldrin, aldrin, chlordane and toxaphene (in that order) were each more effective when incorporated. Faulkner (53) reported that lindane applied at fall planting time was effective in killing diapausing first instar pale western cutworm larvae in winter wheat stands. Pfadt (124) reported on tests with endrin against pale western cutworm. He found endrin to be superior to dieldrin, heptachlor and TDE both by ground and air application. Endrin was found to be as effective when applied to the soil surface as when worked into the soil. Depew and Harvey (41) found endrin superior to six other organochlorine compounds. Endrin became the standard chemical recommended for pale western cutworm control by the mid 1950's and remained so through 1982.

Testing of alternative chemicals for pale western cutworm control has continued. Jacobsen and McDonald (84) tested endosulfan (Thiodan), an organochlorine, and trichlorfon (Dylox), an organophosphate, against the standard, endrin, and found them to be ineffective. McDonald (96) tested 14 organochlorine and organophosphate compounds against endrin as a standard and found chlorpyrifos to be as effective as endrin in overall toxicity to pale western cutworm larvae. Depew (42) reported that, of the 11 compounds tested, monocroptophos, an organophosphate, was more effective than endrin. Depew (43) found that acephate, cyolane, cytrolane, monocroptophos, methamidophos and chlorpyrifos performed as effectively as endrin and should be considered as substitutes for endrin to control pale western cutworm. McDonald (97) compared the contact toxicity of eight pyrethroid compounds against endrin and chlorpyrifos. The pyrethoids were found to be from 4 to 156 times more toxic than endrin to pale western cutworm larvae. Chlorpyrifos and endrin were nearly equal but both were clearly less toxic as contact poisons than as stomach poisons. The pyrethroids for the most part were shown to be more toxic as contact poisons. Jacobson et. al. (83) has shown that the pyrethroid compounds are more effective under cool conditions than are endrin or chlorpyrifos.

Because of its subterranean nature, early investigators felt that natural enemies played an insignificant role in the population dynamics of the pale western cutworm (118, 34). Strickland (150) described many parasites of the pale western cutworm and felt they could influence survival of the larvae. Perhaps because early attempts to control the pale western cutworm by cultural or chemical methods proved futile, there was an added interest in describing its natural enemy complex. There have been many

reports of internal parasites of the pale western cutworm (149, 118, 34, 134, 143, 173, 20). Rearing of larvae collected from varying outbreak conditions indicated that parasitism could account for 20-70 percent mortality and, under favorable conditions could, together with predators and disease organisms, effectively reduce populations of pale western cutworms. Cook (34) and Seamans (134) described various predators of pale western cutworm larvae and adults including predaceous wasps and ground beetles. Sorenson and Thornley (143) and Seamans (134) described the action of arthropod predators in the groups Arachnida, Mantidae, Coreidae, Reduviidae and Phymatidae in attacking adult moths as they feed on flowers. Various bird species have been observed digging larvae from the soil and preying on adult moths (34, 134, 143). The significance of disease organisms was suggested by Cook (34). Walkden (173) listed a number of diseases affecting larvae.

Biological control of the pale western cutworm occurs naturally and may occasionally be a significant population reducing agent. However, applied biological control methods for the pale western cutworm are currently not developed.

In November of 1982, letters were sent by the department to eight principal Great Plains wheat producing states and two Canadian provinces requesting their current control recommendations for army and pale western cutworm. Responses were obtained from all but two states. Endrin has not been recommended for cutworm control in Canada since the early to mid 1970's primarily because of residue problems in the environment and wildlife. Consequently, in Saskatchewan, chlorpyrifos, permethrin and deltamethrin are currently recommended for chemical control of both cutworm species in cereal grains. Saskatchewan was the only respondent describing cultural control options for cutworms. The following is reprinted from "Insect Control on Field Crops - 1982", Saskatchewan Agriculture, Plant Industry Branch, Crop Protection Section:

> <u>Cultural Control</u>
>
> Summerfallow that is kept weed free from August 1 to September 15 will not attract Army or Redbacked Cutworm. Where Pale Western Cutworm is predominant, work summerfallow in late July and allow soil to crust during the same period. Protection is only insured if rains cause a crust to form but not if excessive drying after the rain breaks the crust. If moisture loss from weed growth or soil erosion are a concern the above recommendations should not be followed. Cutworms may be starved in spring by delaying cultivation until weeds are 2.5 to 5 cm high,

then cultivating thoroughly, and seeding no sooner than 10 to 14 days later. Army cutworm damage may usually be escaped by delaying seeding until the larvae mature near the end of May.

In the U.S., chlorpyrifos, deltamethrin and permethrin have not been registered for cutworm control in cereal grains. Chlorpyrifos and permethrin have been tested against army and pale western cutworm in several states including Montana (Appendix II). EPA approved special use of chlorpyrifos and permethrin in Montana, South Dakota and Kansas during 1982. Currently, endrin is the only registered product for pale western cutworm control and the principal product recommended for army cutworm control in all responding states but one. Endosulfan, toxaphene, malathion, parathion and trichlorfon are also registered for army cutworms in small grains but endrin is considered to be more reliable and effective. During 1982 in Montana, commercial pesticide applicators treated approximately 11,000 acres of small grains with endrin, 3,000 with chlorpyrifos (Section 18) and 4,500 acres with permethrin (Section 18) for pale western cutworms (Appendix VI).

F. Review of the Montana 1981 - 1982 Endrin Monitoring Program

Weather conditions in 1980 and 1981 favored a significant buildup of army cutworms in small grains (principally winter wheat). An unusually open winter and warm spring encouraged cutworm activity 4-6 weeks earlier than normal. Near drought conditions in southeastern Montana over the previous two growing seasons resulted in low soil moisture conditions and a 1981 winter wheat crop that was under water stress in many areas. These conditions created a potential for extensive crop loss. Widespread cutworm damage was noted in early March in Custer, Fallon and Powder River Counties. Cool dry conditions made toxaphene ineffective. Since endrin was known to be consistently effective under these conditions it was the logical choice of ground and aerial applicators. Montana Department of Agriculture personnel met in early March with chemical dealers and commercial applicators in the outbreak area and explained the application rates and grazing restrictions for endrin and other cutworm chemicals. Treatments began in southeastern counties by the first week in March and were generally completed in this area by the end of March. As the infestation developed later in more northern and western counties endrin applications proceeded into mid-May. A specific exemption from registration for chlorpyrifos was requested by the Department of Agriculture and approved by the EPA in May and some late treatments were made with this product. Nearly 100,000 acres of small grains in 27 eastern counties were treated commercially with endrin for army cutworm control (Appendix VI). In addition a smaller amount of acreage was treated with toxaphene, chlorpyrifos, carbaryl, and parathion. The cutworm infestation also included alfalfa and pasture, however these crops were not treated with endrin.

A monitoring program was designed by the Department of Agriculture in early March. The objective of the program was to select a number of sites known to have been treated with endrin and follow the degradation of endrin residues in soil, vegetation, water and sediments. After the investigation of fish kills in Sunday Creek (Custer County) resulting from errant applications of endrin and toxaphene, the Montana Department of Fish, Wildlife and Parks was asked to cooperate in the monitoring program to measure the effects of endrin applications on wildlife and fish. Applications of endrin proceeded so quickly that it was impossible for Fish, Wildlife and Parks biologists to adequately assess the impact on fish and wildlife species immediately following the application of endrin. Monitoring was limited to measuring sub-acute levels of endrin in various species.

The monitoring program began in April, 1981 and continued through April, 1982. The Department of Agriculture personnel collected and analyzed over 600 samples of soil, vegetation, water, sediment, fish and other aquatic life. In general, endrin residues were found at various levels in all parameters tested (Table 3). Sample analysis was conducted by the Montana Department of Agriculture Analytical Laboratory with assistance from the U.S. Environmental Protection Agency Laboratory in Denver. Additional samples were submitted by Fish, Wildlife and Parks to Hazleton Raltech Analytical Laboratory, Incorporated (Madison, Wisconsin).

Table 3. Environmental and Wildlife Parameters Sampled for Endrin Residues, 1981-1982.

Wheat Vegetation	Rabbits
Wheat Stubble	Porcupine
Wheat Grain Kernels	Muskrats
Wheat Harvesting Chaff	Rodents
Soil	Predatory Birds
Field Margin Vegetation	Bear
Green Weeds and Regrowth Within Fields	Shore Birds
Baled Straw	Passerine Birds
Water	Deer
Stream and Pond Sediment	Pronghorn Antelope
Fish	Upland Game Birds
Aquatic Invertebrates	Waterfowl
Aquatic Vegetation	

By October of 1981, 68 monitoring sites had been established in 20 of the 27 affected counties. Major sampling occurred in five general time intervals; April, June, July and October, 1981 and April, 1982.

Treatment of sites occurred over a range of dates from March to May. To facilitate data comparison, treatment day was called day zero one on all sites. Residue data were then compared for the same interval of time posttreatment for all sample sites. Samples were not necessarily collected from all sites on all sample dates.

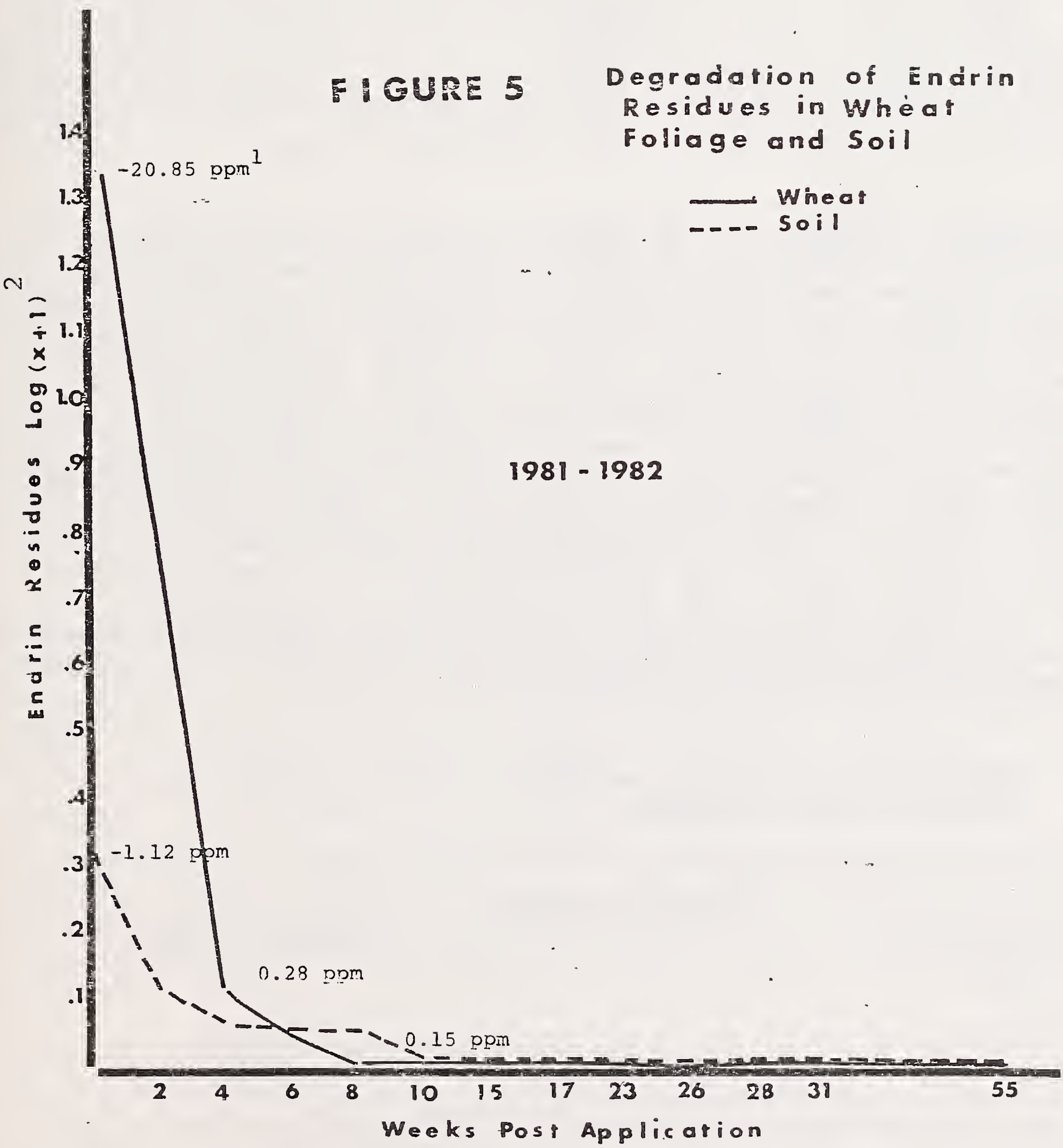
Of principal interest was the rate of endrin degradation in soil and wheat foliage. Table 4 illustrates the analytical results for wheat and soil residues through 55 weeks post application.

Table 4. Degradation of Endrin Residues in Wheat Foliage and Soil in Montana, 1981-1982.

Weeks Post Application	Mean (Range) ppm* Wheat Foliage	Mean (Range) ppm* Soil
0 **	20.85 (17.7-24.0)	1.12 (0.94-1.30)
2	5.32 (2.8- 8.6)	0.34 (0.12-0.79)
4	0.28 (.01 -0.75)	0.18 (0.02-0.48)
6	0.12 (.01 -0.45)	0.14 (0.02-0.35)
8	0.025 (0.001-0.06)	0.15 (0.004-0.45)
10	0.021 (0.003-0.05)	0.037 (ND -0.11)
15	0.013 (ND -0.03)	-- --
17	0.012 (0.002-0.024)	0.018 (0.004-0.03)
27 ***	0.024 (ND -0.052)	0.013 (0.009-0.033)
31 ***	0.016 (.002-0.039)	0.024 (0.007-0.093)
55 ***	0.012 (.001-0.028)	0.016 (ND -0.051)

* Detection limit 0.001 ppm.
** Two days post application.
*** Post harvest samples here were standing wheat foliage.
NOTE: ND = Nondetectable.

Residues on wheat foliage measured two days post application had degraded by 99.9% at 10 weeks post application. Soil residues had degraded by 67% in the same time period. However, residues in both soil and wheat vegetation had reached a plateau by 15 and 17 weeks post application, respectively, and further degraded 8% in wheat and 11% in soil over the next 38-40 weeks. Figure 5 graphically describes the degradation rate in these two sample types. While mean residue levels in wheat foliage and soil at 55 weeks post application were quite small (0.012 ppm and 0.016 ppm respectfully), they were well above the detection limit of 0.001 ppm.



[1] 2 days post application.
[2] Logarithm of the Endrin residues +1.

The degradation of residues in margin vegetation collected immediately adjacent to treated fields followed a pattern similar to that of wheat. Table 5 shows the mean residue level found in this parameter at 30 and 55 weeks post application.

Table 5. Degradation of Endrin Residues in Margin Vegetation, 1981-1982*.

Sample Period (Weeks Post Application)	Average Residues (ppm)	Range of Residues
30	0.020	0.005 - 0.067
55	0.011	N.D. - 0.035

* 22 samples per sample period from identical sites.

In some areas of Montana it is common to graze cattle on grain stubble fields in the fall and to bale the straw residue from harvest to be used for feed. Growers using endrin on their grain fields during 1981 were cautioned not to graze treated fields in the fall or to bale the straw. During October sampling, straw had been baled at four different sites. Table 6 shows the residues found on samples of the baled straw and that found on stubble from the same fields. Endrin residues in baled straw were from 8% to 55% lower than corresponding stubble residues in three cases and 4 times greater in one case. Because of the major role played by the photochemical processes in the degradation of endrin, it would be expected that baled straw residues would be higher than those of stubble collected in October. This sample size is too small to draw firm conclusions. Other environmental factors such as temperature within the bales may be important in degrading residues in bales.

Table 6. Comparison of Endrin Residues in Baled Straw and Standing Wheat Stubble.

Residues (ppm)	
Baled Straw	Wheat Stubble
0.009	0.011
0.010	0.012
0.016	0.004
0.007	0.015

Another source of possible contamination of wild and domestic animals is the green volunteer grain and miscellaneous plant species that emerge in grain fields in late summer and fall. Often these plants may offer the only green vegetation in an area during this time of the year. Samples of this green regrowth were collected during October, 1981, and to a more limited extent in April, 1982. In October, regrowth samples from 20 fields showed mean endrin levels of 0.006 ppm while stubble and soil from the same fields showed mean levels of 0.018 and 0.025 ppm respectively. Regrowth in enough quantity to sample was found in only 4 fields of the 20 fields during April of 1982. The mean endrin levels in regrowth were 0.002 ppm while stubble and soil levels were 0.009 and 0.007 ppm, respectively. While the regrowth levels were 3.6 to 4 times less than corresponding stubble and soil samples, it seems possible that some endrin was absorbed or picked up from the soil by plants emerging in treated fields.

When a persistent chemical such as endrin is applied to a food crop there is always concern for excess residues in the edible portion of the crop at harvest. The grain kernels must be free of detectable endrin residues to meet FDA requirements (no tolerance). During October of 1981, residue levels on grain kernels were checked by two methods. First, areas within treated fields that had been skipped by harvesting equipment during harvest were located. In these skip areas samples of standing grain complete with heads and kernels were collected and threshed by hand. The chaff and the kernels were analyzed separately for endrin residues. Secondly, when it was possible to trace grain from a treated field to a storage bin, samples of grain were collected from the bin and analyzed.

Results of the analyses showed conclusively that endrin contamination of the grain kernels did not occur. Twenty-six (26) grain bin samples were analyzed and all showed no detectable levels of endrin (detection level 0.001 ppm). There were 18 samples of standing grain collected and hand threshed. While endrin levels in the chaff averaged 0.005 ppm (range None Detected - 0.014 ppm), all kernel samples were negative.

During spraying operations, endrin residues could be deposited in aquatic systems through direct application, misapplication, off target drift, or runoff from treated fields. Because endrin is tightly bound to organic matter, leaching is rarely a significant problem.

Removal of endrin residues from water, while dependent upon specific characteristics of turbidity, amount of suspended organic matter, water temperature, water pH, etc., has been shown to occur relatively rapidly. Water samples were collected from ponds and streams only when application to adjacent fields was known to have occurred within the previous 3-5 weeks. Data from two sample sites illustrate the relationship between endrin residues and water. Site 1 was a slow moving shallow creek in

Custer County that meandered through a series of wheat and alfalfa fields. Endrin drifted into the creek during an aerial application to an adjacent wheat field. Within two days dead fish were observed in the creek by neighbors. Samples were collected 5 days post application. Endrin residues in water and sediment were 0.00005 parts per million (ppm) and 0.001 (ppm), respectively. Seven weeks post application, following a heavy rain, several water samples were taken along the creek. All samples showed no detectable levels of endrin. However, a sediment sample collected from the creek 29 weeks post application showed endrin levels of 0.003 ppm. Sediment analyzed 56 weeks post application also showed endrin levels of 0.003 ppm.

Site 2 consisted of a farm fish pond adjacent to a treated wheat field. In this case drift and runoff were suspected causes of contamination. Water samples collected from the pond 4 weeks post application contained no detectable endrin residues, however, 0.07 ppm was found in the sediment.

In early May of 1981, about 8 weeks following endrin applications in Southeastern Montana, water samples were collected from several creeks and rivers in the area. A recent heavy rain had swollen many of the smaller creeks and waters were turbid. Of the eight samples taken only one (Mizpah Creek) contained detectable levels of endrin (0.00007 ppm).

During October, sediment samples were collected from a variety of ponds, reservoirs, and streams throughout the general treatment area. Those sites that proved positive for endrin were resampled in April of 1982. Of the 14 aquatic sites sampled in October, 11 were positive for endrin with levels ranging from 0.001 ppm to 0.01 ppm (mean = .005 ppm). Of the eleven sites resampled in April only 2 were positive, 0.003 ppm and 0.012 ppm (mean = 0.008 ppm). This sample comparison, although small, gives an indication of the stability of endrin in bottom sediments.

Fish were the most extensively sampled aquatic organism. Fish (dead or dying) samples taken from Sunday Creek 5 days post application showed endrin levels of 0.16 ppm and 2.3 ppm. These were two composite samples of several fish each, analyzed on a whole body basis. Two similar samples taken from the same creek 13 weeks post application showed endrin levels of 0.015 ppm in one sample and no detectable residues in the other. Fish species in the samples reflected the principal species in the creek, i.e. carp, flathead chubs, green sunfish and long nose dace. Carp were predominant in the samples.

During May of 1981 fish samples (sauger and carp) were collected from the Yellowstone River at the mouth of Sunday Creek and the Powder and Tongue Rivers. This sample period was approximately 5 weeks after the majority of endrin application in the area. Eight (8) composite samples were collected from a total of three sites. All samples were positive for endrin at levels ranging from 0.0018 ppm to 0.053 ppm.

Fish samples collected from ponds adjacent to treated wheat fields in Choteau County approximately 4 weeks post application showed endrin levels in the kamloops - rainbow trout of 0.05 ppm. At 8 weeks post application endrin levels in two samples were 0.09 and 0.14 ppm and at 17 weeks post application two similar samples showed endrin levels at 0.041 ppm and 0.043 ppm. At 26 weeks endrin residues in three samples from the pond were 0.014 ppm, 0.022 ppm, and 0.008 ppm. In April (52 weeks post application) endrin levels in four trout samples taken from this pond were 0.002, 0.003, 0.002, and 0.002 ppm. The established FDA action level for endrin residues in fish is 0.3 ppm.

The Montana Department of Livestock collected beef fat samples from seventeen (17) sites in six (6) eastern counties in 1981. Sixteen samples were nondetectable at a detection level of 0.01 ppm, and one fat sample had 0.2 ppm of endrin. The United States Department of Agriculture also sampled fat from beef carcasses in eastern Montana. Fifty-two (52) samples were collected. Forty-four (44) of the samples had no detectable endrin at a detection level of 0.001 ppm. The remaining eight (8) samples showed endrin residues ranging from 0.02 ppm to 0.06 ppm. The Montana Department of Livestock sampled milk in the spring and fall of 1981 and 1982. No endrin was found in any of the nearly 1,200 milk samples that were analyzed.

The Department of Fish, Wildlife and Parks also did extensive sampling during this time period. Table 7 is a breakdown of wildlife samples collected and analyzed through November of 1981. Endrin was detected in 14 of 23 wildlife species sampled. While residue levels were low in most species, residues exceeding the 0.3 ppm USDA action level for domestic beef and poultry were recorded in pronghorns, sage grouse, sharptailed grouse, Canada geese, and several duck species. Health officials throughout the United States could not agree on the significance or actual hazard of these residues to humans consuming contaminated wildlife. These officials generally agreed that warnings concerning consumption of waterfowl and upland game birds should be issued to the public. Appendix IV is a total listing of the wildlife samples collected and analyzed for endrin and keto-endrin by the Department of Fish, Wildlife and Parks in 1981 and 1982. The key for interpretation of data may be found at the end of this appendix. A complete report and evaluation of endrin residues in wildlife for 1981 and 1982 will be available from the Department of Fish, Wildlife and Parks.

Table 7. Summary of Numbers of Specimens (by species), Number of Counties Sampled, and Endrin Residues[1] in Wildlife Collected April-November, 1981 in Montana.

Species	No. Specimens (Samples)[2]	No. Animals	No. Counties	Period Collected	Endrin Levels (ppm)[3] Non-detectable	Endrin Levels (ppm)[3] Detectable/No. Sites
BIG GAME						
Black Bear	2	2	1	May	.01 (2)[4]	0
Mule Deer	33	33	9	Jun-Nov	.01 (1) .05 (30)	.07, .12/2 sites
Pronghorn	25	25	10	Aug-Oct	.05 (22)	.06 (2), .53/3 sites
White-tailed Deer	9	9	6	Sep-Nov	.01 (2) .05 (7)	0
UPLAND GAME BIRDS						
Gray Partridge	5	8	4	Aug-Nov	.01 (2) .05 (3)	0
Merriam Turkey	2	2	1	Aug	.05 (2)	0
Ring-necked Pheasant	23	27	5	Aug-Nov	.05 (14)	.05 (3), .07, .079, .09, .11, .13 (2)/5 sites
Sage Grouse	2	3	1	Aug	.05 (2)	0
Sharp-tailed Grouse	33	55	8	Apr	0	22.9/1 site
				Aug-Nov	.01 (1) .05 (9)	.02, .03 (7), .04 (3), .05, .059, .06 .064, .17, .3 (2), .53, 2.02/11 sites
WATERFOWL						
Canada Geese	29	34	7	Aug-Nov	.05 (9)	.03, .051, .055, .07, .08, .13 (2), .14, .27, .28, .31 (3), .32 (2), .36, .37, .40, .52, .55/5 sites
Baldpate/Widgeon	17	18	8	Sep-Nov	.05 (11)	.01 (2), .06, 1.2/2 sites
Blue-winged Teal	18	30	10	Aug-Sep	.05 (14)	.065, .09, .88/3 sites

Table 7. Summary of Numbers of Specimens (by species), Number of Counties Sampled, and Endrin Residues[1] in Wildlife Collected April-November, 1981 in Montana (cont.).

Species	No. Specimens (Samples)[2]	No. Animals	No. Counties	Period Collected	Endrin Levels (ppm)[3] Non-detectable	Endrin Levels (ppm)[3] Detectable/No. Sites
Gadwell	20	22	5	Sep-Nov	.01 (1)	.02, .06(3), .07, .08, .09, .10, .20
					.05 (5)	.21, .23, .28, .31, .32/5 sites
Green-winged Teal	10	14	6	Sep-Oct	.01 (1) .05 (5)	.05, .06/2 sites
Mallard	40	45	13	Sep-Nov	.01 (8)	.01(2), .02(2), .05(2), .053, .06, .08(2),
					.05(17)	.17, .23, .27, .69, 1.35/5 sites
Pintail	5	6	4	Sep-Oct	.05 (5)	0
Ring-necked Duck	2	2	1	Oct	.05 (2)	0
Ruddy Duck	3	5	3	Sep-Oct	.01 (1) .05 (2)	0
Scaup	3	3	2	Sep-Oct	.01 (2) .05 (1)	0
Shoveler	8	8	7	Sep-Oct	.01 (1) .05 (5)	.12, .16/1 sites
OTHER MIGRATORY BIRDS						
Coot	9	9	5	Sep-Nov	.01 (4) .05 (4)	.03(2)/1 site
Mourning Dove	1	1	1	Aug	0	.003
Wilson's Snipe	2	4	2	Oct-Nov	.01 (1) .05 (1)	0

1 Residue levels obtained from 1 of 4 different pesticide analytical laboratories.
2 Composites from several animals of the same species in some cases.
3 Wet Weight Basis.
4 Numbers in ( ) = number of specimens; no number after a residue level indicates one specimen.

Section III. PROPOSED ACTION AND ALTERNATIVES

A. Alternative Selection Process

As a result of environmental contamination with endrin in 1981, it was the decision of the Department that additional restrictions on endrin use, greater than those imposed by the label, should be considered. It was the Department's intent to reduce the potentials for nontarget hazards and endrin residues in the environment.

In 1982 the Department noticed and held hearings on a rule (Appendix IV) to:

1. Restrict endrin use to cutworms control only [A.R.M. 4.10.901(1)];
2. Strengthen reporting requirements for farm applicators using endrin [A.R.M. 4.10.901(3)];
3. Permit endrin use only in fields surveyed by qualified personnel, and found to contain infestations of cutworms [A.R.M. 4.10.901(2)(2)];
4. Permit endrin use in the above situation only if effective alternatives were unavailable [A.R.M. 4.10.901(2)(2)];
5. Restrict endrin use to commercial or government applicators [A.R.M. 4.10.901(2)(3)]; and
6. Strengthen the buffer zone around bodies of water [A.R.M. 4.10.901(2)(4)].

The above rule was analyzed through the Preliminary Environmental Review Process (PER) as required by the Montana Environmental Policy (MEPA). It was determined that numbers 1 and 2 [A.R.M. 4.10.901 (1) and (3)] could be adopted without causing adverse environmental impacts. These two subsections were subsequently adopted in March, 1982. However, it was concluded in the PER that adoption of numbers 3, 4, 5, and 6 [A.R.M. 4.10.901(2)] could result in significant adverse environmental impacts. Therefore it was determined that this subsection should be addressed in a Draft Environmental Impact Statement (DEIS).

Prior to completion of the DEIS, the time limit specified by the MAPA for adopting noticed rules had expired. Since the Department had committed to prepare a DEIS, it was necessary to propose new rules under the MAPA. A number of new rules were considered, in addition to the originally proposed rules. All of these rules basically constituted the alternative actions considered in this DEIS.

The Montana Department of Agriculture considered 14 alternatives. Each alternative was considered in light of several selection criteria: (1) Will the agricultural community continue to have an effective and economic cutworm control method?; (2) Does the alternative satisfy the Department's objective of reducing

environmental and economic impacts of endrin use?; and, (3) Is the alternative enforceable?

Five alternatives were immediately rejected as not meeting the selection criteria. Eight alternatives were considered for comparison with a ninth alternative, No Action. Even though the No Action alternative was considered by the Department to be unacceptable, in that it did not meet selection criteria, it was felt that it provided the baseline, to which the positive or negative impacts of other alternatives could be compared.

B. Alternatives Considered, But Rejected

1. Use Endrin for Pale Western Cutworm Control Only.

This alternative was considered because it would retain endrin for use against the most difficult species to control. Pale western cutworms feed underground and are therefore not easily managed with non-residual chemicals.

It was concluded that this alternative presented a difficult and impossible enforcement situation. From an enforcement viewpoint it is more realistic to restrict crop types on which a chemical can be used, rather than to restrict the chemical to a pest species. It is further complicated by the fact that the young cutworm larvae are difficult to distinguish as to species (pale western vs army) without proper training and appropriate technical equipment. Each field would have to be checked to confirm if those present were pale western cutworms. Pale western cutworms generally do not appear every year but can be expected to appear about one out of every 2-3 years. Endrin would have to be available, but would most likely be used only one year out of three. This alternative was rejected as being unenforceable and for the reasons stated above.

2. Endrin Application Only After Confirmation of an Economic Infestation by Growers, on a Field by Field Basis.

This alternative would require producers to survey their fields, determine the cutworm species present and determine that an economic infestation existed. An economic infestation is a condition in which the damage expected could economically justify a treatment (average of 1 pale western cutworm or 3 army cutworms per linear foot). This alternative is attractive because it would limit endrin applications to those situations which are economically justified.

Presently, producers generally determine a need for cutworm treatment on a field by field basis. Department personnel concluded that this alternative is basically the same as the No Action alternative.

3. Use of Biological Control Agents.

While there are a number of biological organisms (parasites, predators and disease organisms) that attack both cutworm species under natural conditions, none reliably suppress populations and prevent current season damage. As research of biological agents continues, one or several organisms may be found that are effective and reliably control cutworms. If so, biological agents introduced to crop environs could become an alternative to chemicals.

4. Crop Insurance.

Crop insurance was suggested by several groups as being a viable option to replace chemical use. It was suggested that the Department model a program after one reportedly in place in Maryland. Correspondence and personal communication with the university system, the cooperative extension service and the private sector in Maryland failed to locate such a program.

This alternative may have merit. The extensive acreages of small grains in Montana might support a program similar to the hail insurance program administered by the Department of Agriculture. However, a study would be necessary to determine feasibility and potential producer participation.

Implementing a state program to insure small grain growers against cutworm damage would require legislative action. This alternative is impossible to implement at this time.

5. Immediate Cancellation of the Endrin Registration for Use on Small Grains.

This alternative was rejected because of the potential for substantial economic impacts to small grain growers experiencing cutworm infestations. Uncontrolled low infestations of pale western cutworms can result in a loss of 2.4 to 4.2 bushels per acre, and high infestations can reduce yields by 15 bushels per acre (168). Unchecked, these infestations could result in substantial decreases in agricultural production and in farm income.

Currently, effective chemical alternatives to endrin are federally registered for controlling army cutworms. However, endrin is the only federally registered insecticide that is effective against pale western cutworms. Cultural and biological controls are not effective against either species during outbreaks.

Since 1981, alternative chemicals (chlorpyrifos and permethrin) have been granted specific exemptions (Section 18, FIFRA, as amended) for use on small grains to control cutworms. These registrations are contingent upon approval by the EPA and are temporary, never exceeding one year. Applications for renewal of these specific exemptions must be made on a yearly basis. Use of

these alternative chemicals is tenuous and obtaining further specific exemptions is not assured.

If the registration for endrin were to be immediately cancelled and, for any reason, alternative chemicals were not available for controlling pale western cutworms, small grain growers would experience periodic reductions in income and agricultural production. Statewide, as well as to individual growers, these reductions would be considerable.

There are currently no permanent registrations for alternatives to endrin for controlling pale western cutworms. Because of the potential of these insects for causing significant crop losses, and the effectiveness of endrin in controlling pale western cutworms, the Department concluded that the registration for endrin should be retained until effective alternatives attain permanent registrations. The immediate cancellation of the registration of endrin was rejected as not being a viable alternative for further study.

C. Alternatives Considered

Alternative 1. No Action, Endrin Use According to the Presently Registered Federal Label and Current Department of Agriculture Restrictions.

Under this alternative, the use of endrin would be continued for the control of pale western and army cutworms in small grains. No additional restrictions would be placed on its use other than those existing federal labeling requirements and state pesticide statutes and rules already in place.

The probability of a widespread cutworm outbreak in the near future is uncertain. However, past use patterns in Montana indicate up to 30,000 - 40,000 infested acres of small grains will be treated in any given year for one or both species. In the event of a widespread cutworm outbreak this figure could easily reach 100,000 acres.

Alternative 2. Restrict the Use of Endrin to Commercial Applicators Only.

Under this alternative the use of endrin would be restricted to certified commercial applicators. In Montana there are currently 123 commercial aerial and 165 commercial ground, agricultural crop applicators. Under this system the potential for people to come into direct contact with endrin would be limited to those commercial applicators and employees handling, mixing and applying the product. This would limit potential contact to approximately 700 people.

The implementation of this alternative would require the Department to promulgate rules under the MAPA.

Alternative 3. No Endrin Applications Within a Buffer Zone Around Private and Public Waters, 1/8 Mile for Ground Applications and 1/4 Mile for Aerial Applications.

This alternative would increase current endrin label restrictions. Current label restrictions do not specify a buffer zone around ponds on private land; although applicators are warned that excessive contamination and fish kills may occur. The label does specify a buffer zone around lakes and ponds on public lands and along all streams (1/4 mile by aerial application and 1/8 mile by ground). According to the Department of Fish, Wildlife and Parks there are at least 70,000 ponds and potholes in eastern Montana. Many of these are probably on private lands. The intent of this alternative is to provide increased protection from endrin residues for domestic livestock, aquatic organisms, waterfowl and other wildlife utilizing private ponds.

This alternative would require the Department to draft and implement rules under the MAPA.

Alternative 4. Require Commercial or Farm Applicators to Complete Training Provided by the Department of Agriculture Prior to Endrin Purchase.

This alternative would be a method, through education, to train individuals on cutworm control and endrin use. The objective would be to identify sensitive areas in the environment and ways in which potential impacts could be minimized. The Department would be required to establish training courses in several locations in Montana prior to the normal seasonal usage. Close cooperation between the Department of Agriculture and the Montana Cooperative Extension Service to set up the training and notify all the potential endrin users would be necessary. It is anticipated that about 400 commercial and private (farm) applicators would require training initially. Training of new applicators and some retraining for others would be required annually.

The implementation of this alternative will require the Department to promulgate rules under the MAPA.

Alternative 5. Endrin Applications Restricted to Ground Equipment Only.

The current endrin label permits application by aircraft or ground sprayers. Alternative 5 would permit application by ground sprayers only. All label directions that pertain to ground applications would remain unchanged.

The intent of Alternative 5 would be to reduce the hazard of endrin drift to off-target areas. The potential for drift is much greater during aerial applications than during ground applications.

The implementation of this alternative will require the Department to promulgate rules under the MAPA.

Alternative 6. Use of Endrin Only Where Economic Infestations Are Confirmed by Trained Individuals to Exceed 1% of a County's Total Planted Small Grains Acreage in a Given Year.

This alternative eliminates or greatly minimizes the use of endrin, except in an outbreak situation. In recent years, small grains production has occurred on about 6-6.5 million acres in Montana. Cutworms have infested an average of about 37,000 acres of small grains yearly, or about 0.6% of the total harvested acreage. Therefore a 1% or greater infestation of the small grain acreage in a county seems reasonable in terms of defining the occurrence of an outbreak. Alternative control methods would be used to control cutworms until that county's total infested small grains acreage exceeded 1% of the total planted small grains acreage.

Alternative 6 would require training of individuals in pest detection and control and that these individuals be available to check infested grain fields and determine if cutworms were present at economic levels. Field checking would require intensive manpower, travel and communication during the short period in the spring when cutworm larvae are a problem. Trained individuals could be assigned to county extension offices where a grower - county agent communication system is, in most cases, in place. County agents are often the first professionals to be informed of cutworm problems.

The Department of Agriculture would be responsible for coordinating such a monitoring system and for training a corp of "field scouts" each year. The Department would also maintain records, authorize endrin use, provide additional technical assistance and enforce such a program.

The implementation of this alternative will require the Department to promulgate rules under the MAPA.

Alternative 7. Endrin Application Only After Confirmation of an Economic Infestation by Trained Individuals on a Field by Field Basis.

This alternative would allow the use of endrin for cutworm control in small grains only after a survey by trained Department of Agriculture personnel or authorized agents indicated the cutworm populations had exceeded the economic threshold and crop loss was imminent. Treatment on a field by field "as needed" basis would reduce unnecessary or ill-timed applications of endrin and possibly result in a reduction in the total number of acres treated annually.

This alternative would require a field by field survey effort, and an extensive staff trained in cutworm survey techniques and economic threshold assessment methods.

The implementation of this alternative would require the Department to promulgate rules under the MAPA.

Alternative 8. Limit Endrin Sales in Montana to 5,000 Gallons Per Year.

This alternative would have the effect of limiting endrin treated cutworm acreage to between 32,000 and 40,000 acres per year. This means that during an "average" cutworm year endrin would be available to control the infested acreage. In an outbreak year, after 40,000 acres had been treated, whatever alternative control methods were available would be used to treat the remaining acreages.

The implementation of this alternative would require the department to promulgate rules under the MAPA.

Alternative 9. Suspend Sales and Use of Endrin - Cancel Endrin Registrations When Alternatives are Registered by the Environmental Protection Agency (Proposed Action).

The implementation of this alternative would require the department to promulgate rules under the MAPA to suspend sales and use of endrin and, when alternatives are federally registered, to cancel the registration of endrin for use on small grains. The registration for endrin use in apple orchards to control voles would be cancelled immediately.

D. Proposed Action

The proposed action is to proceed with Alternative 9, the eventual cancellation of the registration for endrin in Montana as authorized by the Montana Pesticides Act, Sections 80-8-105 (3)(a) and 80-8-201(3). The Department's objective is to assure that grain growers have effective methods available to control cutworms, and to assure that the effects of endrin to humans and other animals are minimized. It has been the Department's stance that additional restriction of endrin use was necessary, and that Alternative 1 (No Action) was not acceptable. It has been further concluded that Alternatives 2 through 8 do not sufficiently reduce some of the potential environmental impacts of endrin. These alternatives are not acceptable at this time because effective chemical alternatives to endrin are currently available.

The proposed action on endrin for use on small grains will proceed in two phases. Initially, administrative rules (Appendix V) will be issued to suspend further distribution and sale in Montana of products containing endrin for use on small grains. The rule will permit farm and commercial pesticide applicators to use existing stocks of endrin for labeled uses. Additional restrictions will be imposed concerning applications of endrin around bodies of water on private lands, and reporting of applications (Appendix V, page 166). The rule will suspend further interstate shipment of endrin into Montana for use on

small grains. Individuals transporting endrin into the state for sale or use will be subject to penalties of the Montana Pesticide Act. This rule will be effective upon passage.

If chemical alternatives to endrin become unavailable in Montana, the Department will reinstate restricted sales and use of endrin to control cutworms in small grains. In this eventuality, additional restrictions concerning the reporting of endrin sales would be imposed.

Until the time that chemical alternatives to endrin are federally registered, the Department will continue to request specific exemptions or state registrations for these alternatives. The most promising alternatives at this time are chlorpyrifos, fenvalerate, and permethrin. Endrin will be cancelled upon issuance of a federal registration for any of these alternative chemicals for use on small grains in Montana (see Appendix V for proposed rule). Farm applicators and other categories of pesticide applicators would have two years in which to use existing stocks according to label directions. At the end of that period further application of endrin would be prohibited and existing stocks could be disposed of according to state and federal laws concerning hazardous waste disposal.

The cancellation of the registration of endrin for grasshopper control, effective 3/31/82, will be continued.

The registration of endrin for control of meadow voles in apple orchards will be cancelled.

Section IV. DESCRIPTION OF THE AFFECTED ENVIRONMENT

In general, the portion of Montana that will be affected by rules to restrict endrin use will be that area east of the Rocky Mountains, or Great Plains Montana (Figure 6). This is the area where, historically, cutworm outbreaks have been most frequent and severe, although isolated outbreaks have occurred in the mountain valleys of Western Montana. Table 2 (pages 25-29) shows that, since 1954 when endrin was first used for cutworm control, major outbreaks in small grains occurred during 14 years, and were most frequent east of the Rocky Mountains. Any affects resulting from the restrictions of endrin use will be most measurable in this area; hence, it is appropriate to restrict discussion of the affected environment to the eastern three-fifths of Montana.

A. Physical Environment

The rolling expanse of Great Plains Montana with its wide vistas is the essence of "Big Sky Country". The diversity of geography and weather makes summarization of the conditions of this land difficult. Winters may be extremely cold, summers hot, and rainfall infrequent. Varied geographical areas include timbered outlying mountain ranges, rolling grasslands and grainstrips, scrubby breaks, and narrow, irrigated, alluvial valleys. Good descriptions of environmental regions within Great Plains Montana were given by the Montana Environmental Quality Council (51).

Several outlying mountain ranges give stark elevational relief, however the land is basically of broken, rolling plains that dip eastward reaching their lowest point at less than 2000 feet where the Missouri and Yellowstone Rivers leave Montana. Average yearly precipitation ranges from about 12 to 16 inches over much of the eastern portion of Montana to 16 to 40 inches in the Rocky Mountain outliers or other higher regions. Precipitation throughout most of Eastern Montana is inadequate to give maximum crop yields and variations in agricultural production are often due to the amount of precipitation that has occurred during the growing season. The runoff from snow in the western mountains feeds many streams and rivers that flow through Great Plains Montana and provides water for irrigation, municipal purposes, recreation, livestock, and wildlife.

In comparison with mountainous valleys of Western Montana, the winters of the plains are generally colder and the summers hotter (Table 8). The growing season ranges from 120 to 130+ days over most of the major agricultural areas. This rigorous, semiarid climate is responsible for the grassland climax community that originally typified the Great Plains. Montana grass prairies have been largely replaced by small grain farming or livestock grazing.

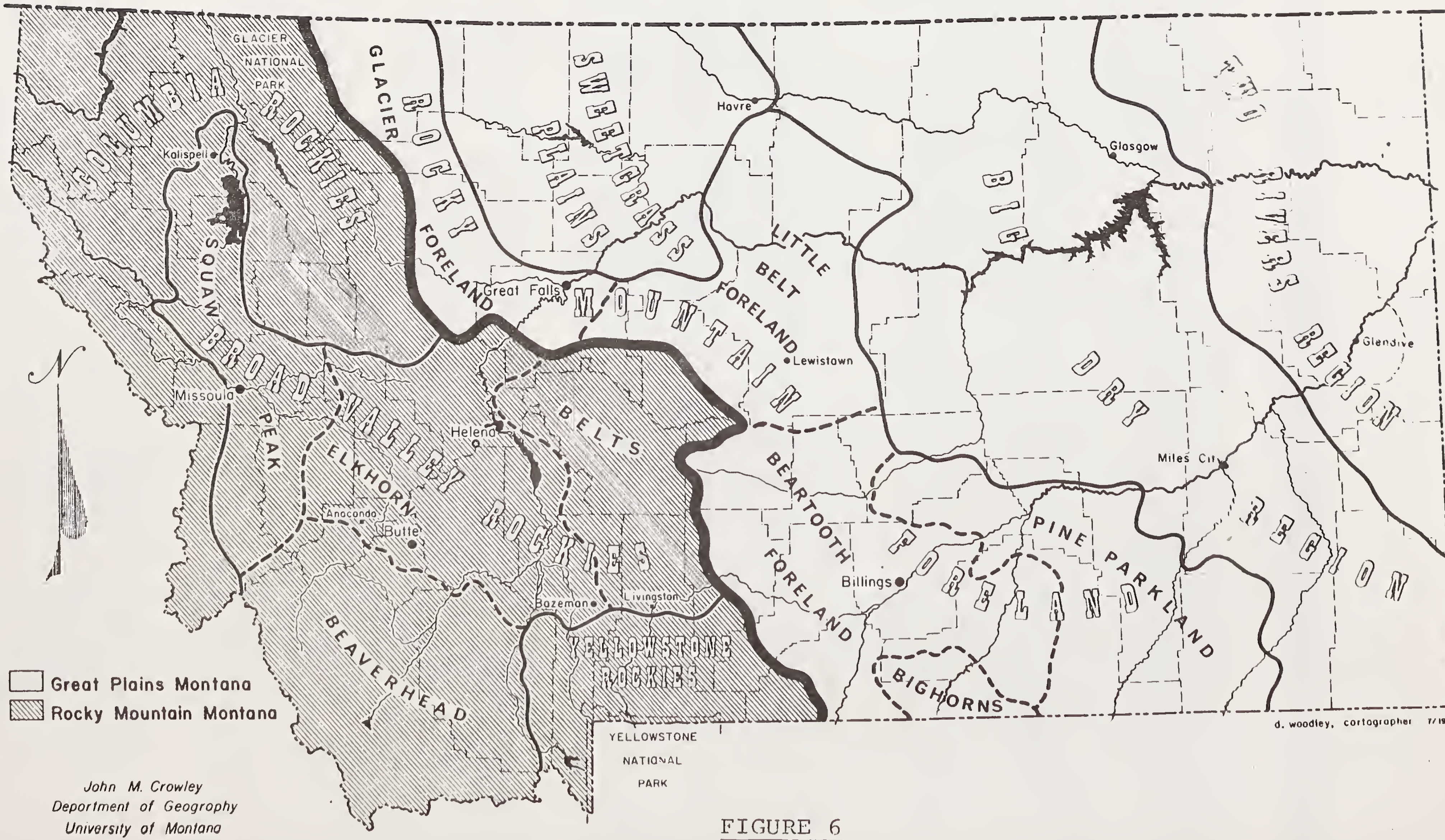


FIGURE 6

Montana's Environmental Regions

(From: Montana Environmental Indicators, 1975, Environmental Quality Council)

Table 8. Average Maximum and Minimum Temperatures[1] (degrees fahrenheit) for 5 Recording Stations in Montana.

Station	Minimum	Maximum
Billings	-8.4	73.2
Glasgow	-23.2	95.2
Great Falls	-12.8	94.8
Havre	-22.0	100.0
Miles City	-19.4	100.8

[1] Five year period from 1974 to 1978.

Grassland Ecosystem of Eastern Montana

Great Plains Montana lies within a large transition zone between the expansive temperate grasslands of the Midwest United States and the forested Rockies. The dominant vegetative feature of this transition zone is the grasses - the climax community that generally develops in areas where precipitation is between 10 and 30 inches per year. In botanical terms it is the short grass prairie and, in some locations, the bunch grass prairie. Few areas of pristine or undisturbed prairie remain intact but, from those that do, the climax species can be inferred and vary depending upon geography, precipitation, and soil type (129, 119). For example, high precipitation (14-19 inches) favors rough fescue, and low precipitation (10-14 inches) favors bluebunch wheatgrass. Light soils are dominated by such grasses as needle and thread, western and thickspike wheatgrass, green needlegrass, and little bluestem. Heavy or saline soils favor the growth of species such as alkali sacaton, wheatgrasses, saltgrass, and greasewood. In general, broadleaf forbs and shrubs compose a small percentage of undisturbed communities. On various foothill and outlying mountains with higher precipitation and more frigid temperature regimes, a forest-grassland complex is commonly present. These systems are often dominated by forest species such as Douglas fir, rocky mountain or Utah juniper, ponderosa or limber pine, subalpine fir, or Engelmann spruce mixed with various grasses, broadleaf forbs, and brush.

The productivity in terms of plant material produced per acre in a growing season is low in the Great Plains. Native grasses are adapted to the overriding physical feature of this region - low precipitation. Deep root systems (up to 6 feet) to procure soil moisture, life cycles that correspond to historical rainy periods, and the ability of communities to withstand periods of drought are several notable features of the grasses. The soil of healthy grassland communities typically has a deep layer of dark humus rich in decomposing organic material. This humus layer can average about 600 tons per acre and provides tremendous water holding capacity acting like a sponge to draw and retain moisture

where it can be utilized by plants (151). Another feature of plains soils is the potential for salts that can be derived from underlying and surrounding marine shales. Under natural conditions, salts percolate in the ground water to about the depth of the root zone where they may accumulate with little effect on plant growth. When the native vegetation is removed as in a grain cropping system, and deeper percolation of water is allowed during fallow periods, salts may move downslope and occasionally appear as saline seeps.

Periodic fire, a natural phenonmenon of the Great Plains prior to settlement by humans, is thought to have favored the growth of grasses at the expense of fire susceptible, slow growing woody plants. Suppression of fires may be partly responsible for the appearance of woody species such as sagebrush on rangeland.

About 99% of the total 61.7 million acres in Great Plains Montana is used agriculturally, either as range or pasture (47.4 million acres) or as cropland (14.3 million acres). In 1976 about 40% of the rangeland needed conservation treatment (129), usually as a result of excess grazing which sets back the climax grass community. Symptoms of overgrazing generally are the appearance of species typical of earlier stages of succession such as big sagebrush, foxtail barley, saltgrass, Idaho fescue, and broadleaf forbs.

The humus rich soils of many Great Plains areas have produced bumper crops with a minimum effort in initial land preparation. In 1981, over 95% of the wheat harvested in Montana came from the Great Plains Region, and about 65% of the state's wheat harvest was from 13 Great Plains counties concentrated in the Golden Triangle area and the Northeastern corner of the state (100).

Water Resources - Surface Water

Much of the surface water resources available to Great Plains Montana originate in Rocky Mountain Montana headwaters or outside the State. Surface water runoff in the Great Plains usually amounts to less than an inch yearly, in fact, many farming areas periodically experience a deficit in usable water (104). Surface water runs through 2 major drainage systems, the Yellowstone and Missouri Rivers. Several intermittent tributaries of the Belle Fourche-Cheyenne River System penetrate the extreme southeast corner of Montana. Total outflow of water is about 16.9 million afy (acre feet per year) from the Yellowstone, Missouri, and Belle Fourche-Cheyenne Rivers. Total water withdrawals amount to about 10.6 million afy with most of this going for irrigation (105) (Table 9).

Table 9. Water Withdrawals From the Missouri and Yellowstone River Basins (afy)[1].

	Yellowstone	Missouri
Irrigation	3,491,000	6,710,000
Thermoelectric	183,000	-0-
Self-supplied Industry	56,000	19,000
Municipal and Industrial	33,000	53,000
Livestock	12,000	21,000
Rural Domestic	4,000	10,000

[1] Adopted from reference 109.

Over half of the surface water that is withdrawn for irrigation is returned either unused or as runoff from croplands. Most of the irrigation withdrawals occur during the dry months of summer - July and August - which may significantly reduce flows on some tributaries.

In 1970, municipal systems withdrawing surface water served about 339,000 Montanans or about 50% of the state's population (109). Great Falls and Billings, the state's two largest population centers, have municipal systems that use surface water, as do most large communities near permanent streams and rivers. On a statewide average, 38% of municipal water is used by industry and 62% for residential uses. Average use was about 267 gallons per capita day in 1970 with much of this being returned to its source and becoming available to additional downstream users. Water used for lawn sprinkling (50% of the total withdrawal) is almost entirely lost through evapotranspiration (109).

About 0.15% of all water withdrawn from surface sources in Montana was used for livestock drinking water in 1970, with the majority of this use occurring in Great Plains Montana. The total of 33,000 afy withdrawn for livestock consumption from the Missouri and Yellowstone River basins in 1970 (109) is probably 10-15% lower now because of a recent decrease in the numbers of livestock on farms and ranches (100).

The water quality of streams of Great Plains Montana can generally be described as good but degrading somewhat downstream. The Yellowstone and Missouri, for example, both support salmonid fisheries upstream but lower parts support warm water fisheries with such species as catfish, sauger, walleye, paddlefish, and sturgeon.

The quality of the Yellowstone River is suitable for drinking, other municipal purposes, swimming and recreation along the entire length in Montana with normal water treatment procedures. Total dissolved solids (TDS), turbidity, suspended solids, and hardness; all of which are rough measures of water quality, tend

to increase downstream (Table 10). From about Forsyth to the state border, total dissolved solids periodically exceed the 500 mg/l limit recommended for drinking water by the U.S. Public Health Service if alternate supplies are available (18).

Table 10. Average Measurements of Water Quality, Yellowstone River in Montana[1].

	Turb (NTU)	TDS (mg/l)	Susp. Solids (mg/l)	Hardness $CaCO_3$ (mg/l)
Livingston	4	146	41	72
Billings	18.6	231	195	140
Forsyth		408	303	206
Miles City		444	167	225
Sidney	85	503	307	252

[1] Adopted from reference 163.

The general water quality of the Missouri River follows a similar pattern to the Yellowstone River with TDS, hardness, turbidity, and suspended solids increasing downstream (163, 14) (Table 11). Measurements taken near Culbertson probably were influenced by Fort Peck Reservoir.

Table 11. Average Measurements of Water Quality, Missouri River in Montana[1].

	Turb (NTU)	TDS (mg/l)	Susp. Solids (mg/l)	Hardness $CaCO_3$ (mg/l)
Near Great Falls	12	306	27	156
Judith Landing	205	408	598	206
Robinson Bridge	340	433	1397	206
Culbertson	19	483	154	255

[1] Adopted from references 163 and 14.

Most of the larger tributaries of the Yellowstone and Missouri Rivers accumulate dissolved and suspended materials along their courses becoming more turbid and alkaline at lower reaches. Some, like the Bighorn, support outstanding salmonid fisheries in upper reaches and others like the Powder have no substantial game fisheries but are used as spawning areas. Several rivers like the Milk, Poplar, and lower reaches of the Musselshell have high

levels of dissolved solids that create a salinity hazard if used for irrigation (Table 12).

Table 12. Average Values for Selected Water Quality Measurements for Larger Streams in the Missouri and Yellowstone River Basins, Montana[1].

	Turb (NTU)	TDS (mg/l)	Susp. Solids (mg/l)	Hardness $CaCO_3$ (mg/l)
Bighorn River (near Bighorn)	8	644	101	318
Tongue River (near Miles City)	39	563	541	338
Powder River (near Terry)	1647[2]	455	144	226
Marias River (near Chester)	1.7	357	7	225
Musselshell River (near Mosby)	77	1506	1401	633
Milk River (near Nashua)	18	1080	65	397
Poplar River (near Poplar)	12	1046	42	216

[1] Adopted from references 163 and 110.
[2] Near Locate.

Analyses for several pesticides in river waters are routinely conducted by the U.S. Geological Survey (163). During water year 1981, monthly analyses were conducted at 3 locations on the Missouri River, 2 locations on the Yellowstone, the Musselshell, Rock Creek in the Milk River Basin, the Milk River, the Tongue, and the Powder River. Routine analyses were made for chlorinated hydrocarbons, several organophosphate insecticides, and at two locations analyses were conducted for commonly used herbicides. All results were negative except for the herbicide, picloram, which was detected in the Powder River near Moorhead at 0.01 ug/l in October, 1981.

A survey was conducted in Montana in 1980 which identified reservoirs with a surface area of over 1 acre. A total of 6,346 reservoirs were identified (Figure 7) (6, 111), about 90% of which are in Great Plains Montana. Of these, 3,518 had a

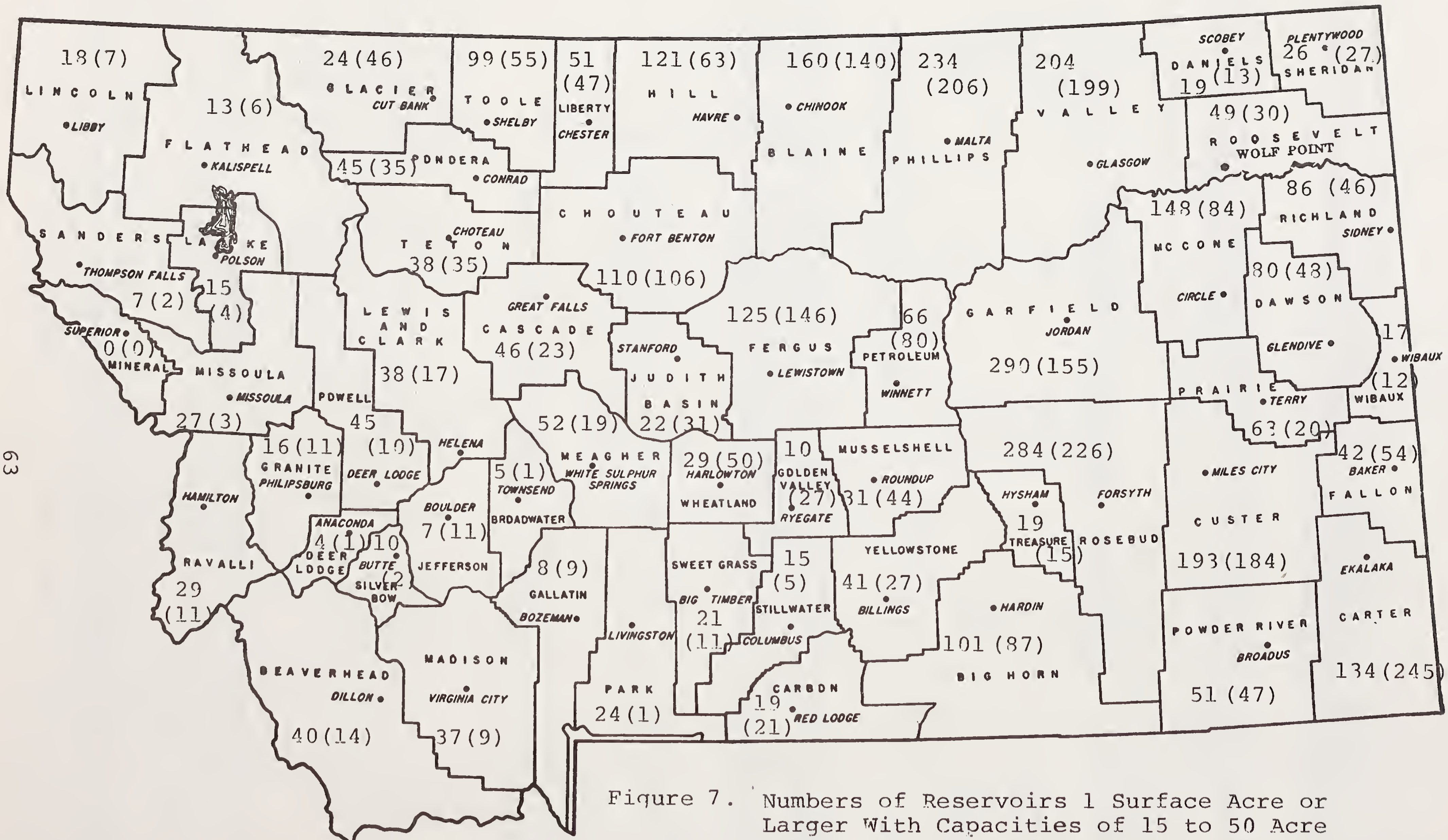


Figure 7. Numbers of Reservoirs 1 Surface Acre or Larger With Capacities of 15 to 50 Acre Feet. Reservoirs With Smaller Capacities are in Parentheses.

capacity of 15 to 50 acre feet or larger. The remaining 2,828 did not meet this size criteria. Several large reservoirs are located in Great Plains Montana including Fort Peck, Bighorn, Tongue River, Tiber, Fresno, and Nelson.

Northeastern Montana is part of the prairie pothole region, an area noted for waterfowl reproduction. A 1965 survey showed a total of 136,425 potholes, stock ponds, and dugouts in this region (178) (Table 13). Some of these bodies of water are temporary in nature, existing only during rainy periods or during spring runoff.

Table 13. Number of Potholes, Stockponds and Dugouts in Northeastern Montana[1].

	South of Missouri River		North of Missouri River	
	No./Mi^2	Total	No./Mi^2	Total
Potholes	0.41	16,605	1.74	57,420
Stockponds	1.13	45,765	0.69	13,770
Dugouts	0.03	1,215	0.05	1,650
	1.57	63,585	2.48	72,840

[1] Adopted from reference 178.

In Great Plains Montana about 1,043 ponds and lakes support game fisheries. Of these, 39% are on, or partially on, private lands.

Water Resources - Ground Water

Ground aquifers are an important source of water to Great Plains agriculture and to those communities without a quality surface water source. About 66,934 wells have been identified in Montana, of which 61% are used for domestic purposes, 28% for irrigation and livestock, and 1% for municipal and other public supplies. About 447,500 people or over 60% of the State's population are served by public wells or rural domestic wells. About 2.59 million acres are irrigated with ground water.

Most groundwater withdrawals are from recent alluvial and glacial deposits or from cretaceous bedrocks. Two important cretaceous formations include the Fort Union Formation in the eastern 1/3 of Montana and the underlying Eagle Formation in Central Montana. Most water bearing layers in the Fort Union Formation are at a depth of 100 to 300 feet and will yield adequate supplies for domestic and livestock purposes. The Eagle Formation is an excellent aquifer where it is exposed by geologic uplifting and gives yields up to 250 gallons per minute (gpm).

In Northeastern Montana several aquifers are present in buried, preglacial channels of the Milk and Missouri Rivers and other tributaries. These aquifers lie at varying depths ranging from 5 to several hundred feet and produce variable yields ranging up to 1000 gpm (113).

B. Wildlife Resources

A large portion of the mammals that occupy the Great Plains are either running or burrowing types, behaviors that offer some protection in this open habitat (115) that was once dominated by bison. Now, the most important native grazer of Montana plains is probably the pronghorn (antelope). Pronghorns, whose numbers have increased from lows in the early 1900's, are able to cohabit with moderately intensive agriculture. Their normal diet is supplemented by cultivated grains and legumes when native forbs and grasses are in short supply from autumn to early spring (138). Antelope occur on over 60% of the land area of Great Plains Montana (105).

Mule deer occur on about 90% of the land area of Eastern Montana and white-tailed deer on about 20% (105). White-tails find suitable habitat in most drainages that have brushy and/or tree cover; while mule deer are not as confined in their choice of cover and occupy larger areas of hilly rangeland, upland forests and sage, and farming areas interspersed with uncultivated lands. About 78% of the farms in Montana are inhabited by either mule deer or white-tailed deer (103) where they take advantage of cultivated grains, legumes and haystacks as dietary supplements.

Other mammals commonly found on the Great Plains of Montana, often in conjunction with agricultural areas, include burrowers such as black-tailed prairie dogs, white-tailed prairie dogs, Richardson and thirteen-lined ground squirrels, and northern pocket gophers. White-tail jackrabbits, raccoons, striped skunks, a variety of small mammals, and carnivores such as coyotes, fox, and weasels are also common. One endangered mammalian carnivore, the black-footed ferret, is a secretive inhabitant of prairie dog burrows where it apparently preys on prairie dogs and, possibly, other animals.

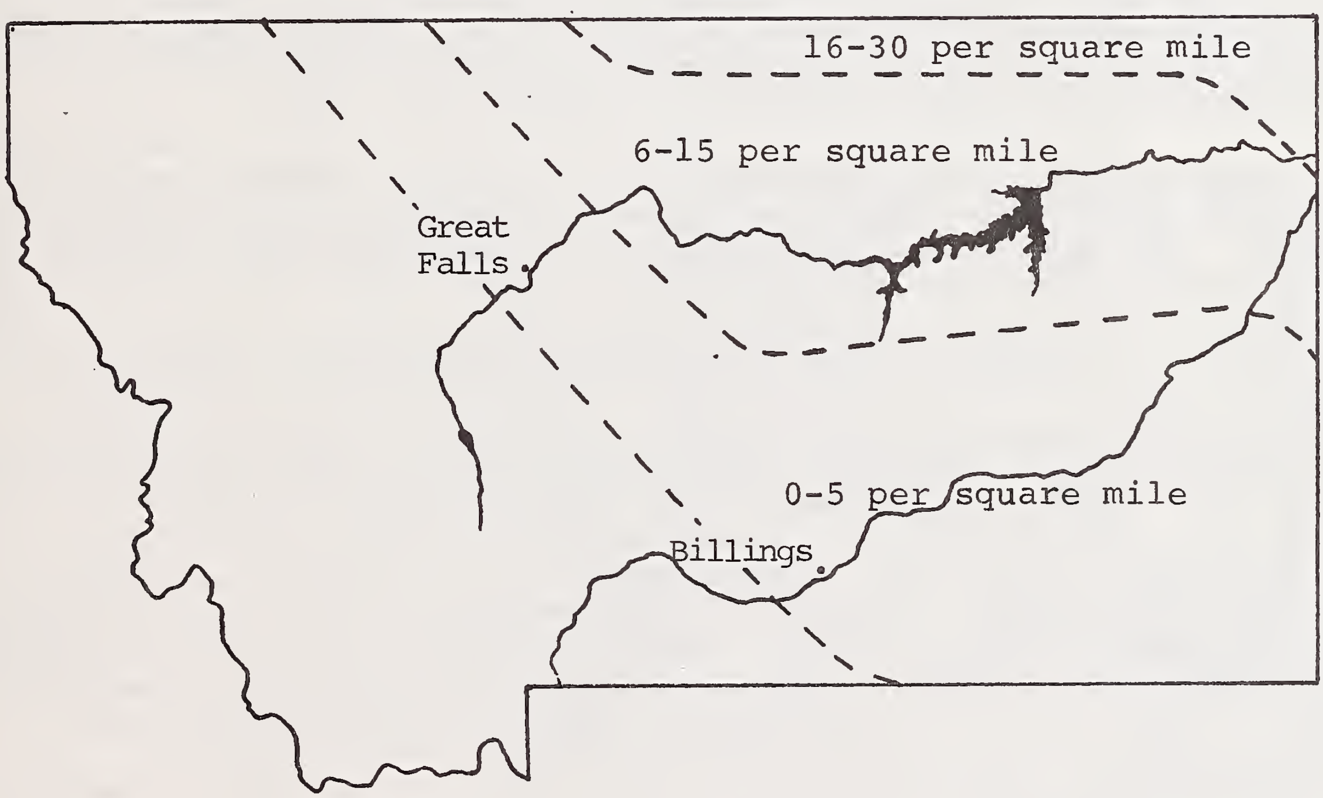
The prairie pothole region, one of the most important waterfowl production areas of this continent, extends into Northeastern Montana (86, 140). Ducks also find nesting habitat on a number of the reservoirs built on private lands for livestock water, irrigation, and soil conservation. The Highline area north of the Milk River has supported breeding duck densities of 16-30 per square mile (Figure 8). A 1965 survey estimated 727,000 breeding ducks in the northeastern half of Montana (178). Over 95% of the ducks surveyed were dabbling ducks. Of these, mallards composed 44%, pintails 28%, gadwalls 10%, and blue-winged teal 5%. Around 60,000 mallards find enough open water to winter in Montana.

Several breeding areas for Canada geese are found in Eastern Montana. These include the Yellowstone River, Medicine Lake,

Fort Peck Reservoir, and other reservoirs and streams. One major flyway passes through eastern Montana with numerous geese making brief stops during migrations.

Dabbling ducks and geese take advantage of grain and forage crops to supplement their diets. Young grain plants and hay are consumed during spring and early summer. As crops ripen and broods attain flight, feeding on grains begins, often many miles from breeding locations. Migrating birds also take advantage of grain that is left in the fields after harvest.

Figure 8. Approximate Average Densities of Breeding Ducks in Eastern Montana (86).



Several species of native and introduced upland game birds are found in Great Plains Montana, notably the sage grouse, sharp-tailed grouse, ring-necked pheasants, and gray (Hungarian) partridge. Sharptails are native birds and are generally found throughout 64% of Montana, or the eastern two-thirds, on grasslands, scrub forests, or edge habitat. Where suitable cover is available, sharptails will coexist with agriculture. The diet of these birds varies seasonally, consisting primarily of buds and catkins from shrubs and rosehips during the winter; and green grasses, forbs and flowers during the spring and summer. A good portion of the summer diet can consist of insects such as grasshoppers (85). Although sharp-tails are less reliant on

cultivated crops than other upland game birds, they will occasionally utilize grains and forage legumes as food.

The sage grouse, another native species, is found throughout Great Plains Montana (141). Sage grouse are strongly dependent upon sagebrush and related plants for food and cover. Sagebrush comprises the majority of their diets. During the spring, sage grouse will occasionally utilize cultivated crops such as clover or alfalfa (85).

The ring-necked pheasant and gray (Hungarian) partridge are introduced species that are generally distributed throughout Montana although numbers of pheasants have declined in recent years. Both species have the ability to thrive in agricultural areas, particularly where edge habitats and areas of weedy or brushy cover are maintained. Certain agricultural practices including monoculture plantings and clean farming have not benefited either species. The foods of both consist of cultivated grains, seeds, native plants and a small amount of insects during the spring and summer. Agricultural crops commonly comprise 75% or more of their diet. During the fall and winter unharvested grain and waste grains from various sources are commonly the major dietary components (85, 89).

Two species of mountain grouse, blue and ruffed grouse, are found in outlying mountain ranges and forested habitat on the Great Plains. The chukar partridge has been introduced into several areas of the state including Carbon County (141).

A variety of nongame birds inhabit Eastern Montana. Several species nest on the ground and may typically be found in farmed areas. These include horned larks, meadowlarks, and various species of native sparrows that may nest in or near fields and forage for insects or grains. The short-eared owl nests on grasslands and may hunt for small mammals in cultivated lands as may the great horned owl. Other raptors, such as the northern harrier (marsh hawk) and red-tailed hawk, may nest near and hunt in cultivated fields. Several species of birds such as gulls and sandpipers, not typically found in dryland farming areas, may at times enter grainfields to feed on invertebrates uncovered by tilling (55). Migrating blackbird flocks commonly stop in grainfields and consume grains in the fall, or insects and waste grain in the spring.

About 55 to 60 species of fish are found in various locations in Great Plains Montana. Game species that could be stated as being typical of the region include warm water fishes such as walleye, sauger, channel catfish, sturgeon and paddlefish. Salmonid fisheries are present in the upper reaches of streams and in streams flowing from southern mountains. Rainbow trout are found in the Yellowstone to about Pompey's Pillar, in the Bighorn, in the upper Tongue, in the Missouri to below Fort Benton, in the upper Milk River, and in other streams. Brown trout have a similar distribution if not slightly more limited.

Paddlefish offer an important fishery in the Yellowstone below Forsyth and the Missouri below Fort Peck and upstream to the Marias River. Stream fisheries for sauger, walleye, northern pike, largemouth bass, smallmouth bass, ling, channel catfish, and sturgeon occur largely on the Yellowstone below Billings and the Missouri below Great Falls.

Several hundred reservoirs, ponds, and lakes, most located on private lands, support fisheries in eastern Montana, and a number of uncounted private ponds support local fishing. Commercial fisheries exist for nongame fish on Fort Peck and Medicine Lake in eastern Montana (105).

Wildlife Species of Special Concern

Five endangered species occur, or may occur, in Great Plains Montana (54). The black-footed ferret is thought to exist only in the extreme southeast corner of Montana where it has an uncertain existence that relies almost exclusively on prairie dogs. Burrows are used as shelter and the majority of the diet is of prairie dogs although other animals may be taken as well.

The migration route of the whooping crane, a very rare, endangered species passes through North Dakota although the edge of the flyway is in Montana. Whooping cranes can occur in Montana during about 60% of the spring migrations and 20% of the fall migrations (55). These wading birds prefer aquatic habitats and associated organisms as food. However, migrating flocks may land in cultivated fields and feed on insect larvae.

The possibility of encountering a gray wolf, another endangered species, is remote in Eastern Montana. However, there are several reports of gray wolves along the Hi-Line area.

The original breeding range of the endangered peregrine falcon includes the great plains; however, no nesting pairs are known to be in Montana at this time. Recent reports are for migrating individuals. Food of this species consists of live prey, usually small birds, that are captured on the wing.

Bald eagles nest in Montana and winter along several waterways. These birds rely on fish as their primary food; however, scavenging on almost any type of kill does occur. Bald eagles will scavenge when they are not fishing, and are known to consume carcasses of dead rodents resulting from rodent control operations, dead fish, road killed deer, or even garbage.

A number of animals have been designated as species of special concern by the Department of Fish, Wildlife and Parks in Montana because of special sensitivity to disturbance, reduced populations or habitat, or because of unique characteristics (54). Some species found in the Great Plains that may utilize grain fields deserve mention.

The bats that are of special concern include the Keen's myotis in Northeast Montana and the big-eared bat scattered throughout Montana. These insectivores feed primarily on flying adult insects such as those emerging from water or flights of terrestrial adults such as noctuid moths.

The western meadow jumping mouse, a rodent of special concern, occupies grasslands in the eastern fourth of the State. This uncommon nocturnal mammal builds summer nests on the ground surface or beneath woody cover, and feeds chiefly on various seeds, insects, and fruits. Most of the larger mammals of special concern are coniferous or mountain species; however, two carnivores, the lynx and wolverine, may rarely be encountered along the Highline or in outlying mountains or foot hills (156).

Of the 29 species of birds now designated as species of special concern in Montana, at least 15 can be encountered in grain farming areas of Great Plains Montana. Bobolinks commonly frequent haylands, the dickcissel inhabits grainfields and weedy areas, and the clay-colored sparrow and Brewer's sparrow both inhabit open brushland and sagebrush areas. Field sparrows commonly are seen in abandoned or grassy fields. These species will eat various seeds and insects depending upon the season.

The ferruginous hawk is common on the Great Plains where it feeds almost exclusively on rodents. Cooper's hawk, an inhabitant of open woodlands and wood margins, may forage for prey some distance from the nesting site. Golden eagles as well, will be seen in a variety of situations in Eastern Montana. Prairie falcons and merlins (pigeon hawks) inhabit open plains or wooded areas and capture living prey such as birds, mice, and insects.

The Charadriiformes form a diverse group of wading or swimming birds that feed primarily on aquatic invertebrates. Several species pass through Montana on long migration routes and may stop in cultivated fields and feed on insects. The mountain plover, long-billed curlew, and upland sandpiper breed in the grassy plains, sage, and meadows of Eastern Montana, usually not far from water.

The burrowing owl is an inhabitant of prairie dog burrows and may forage at least a mile from the nest. Food consists of a variety of animals; however, insects such as ground beetles and grasshoppers are important as are microtine rodents and, when available, aquatic species such as crayfish and frogs. The long-eared owl nests in woods near open country and may forage for prey in cultivated areas.

The eastern bluebird is found in the Wibaux area nesting near farms and roadsides where it feeds primarily on berries and insects caught on the wing.

Several amphibians of special concern including the Dakota toad, smooth green snake, milk snake and plains hognose snake are also found in Eastern Montana.

C. Human Environment

A state as big as Montana with its total population of 786,000 people, is immediately rural in nature with most of the populace having some kind of direct relationship with agriculture and the outdoors. The vast two-thirds of Montana called Great Plains Montana has a population of about 402,000 people (161). Of these some 146,000 live in the State's two largest urban centers, Billings and Great Falls. The total urban population of Great Plains Montana is about 237,000 people[1]. The agricultural population occupies greater than 50% of the land area of Great Plains Montana and numbers about 16,696 people or about 4% of the area's population (160) (Table 14).

Several areas of Eastern Montana are notable in their support of a farming populace. The Golden Triangle; between Great Falls, Havre, and Cutbank; with its gently rolling, glaciated terrain is Montana's premier winter wheat area. Probably no other area of the State is so completely used for farming. A glaciated area occurring in the eastern half of the Hi-Line is another extensive grain farming area in Northeastern Montana. Gentle terrain allows use of the large machinery of modern grain farming practices, and fertile soils give productive harvests. Because of the harsh winter climates the emphasis is on spring planted wheat.

The sparce rural population of the area extending from Garfield County to the Southeast corner of the state results from the thin, poor soils that are generally not as conducive to farming. Ranching is the major rural enterprise of the area; however, typical range supports only 1 cow per 20-30 acres so ranches are, of necessity, large in size.

Central Montana surrounding Lewistown is mainly an agricultural region with cattle and sheep the most important enterprises; however, extensive grain farming is present west and north of Lewistown as well as irrigated farming along the Musselshell and Judith Rivers.

The alluvial valley of the Yellowstone River supports a relatively dense rural population. Several crops unique in Montana are grown in addition to the staple grains and hay. These include sugar beets, dry beans, and corn.

Business Patterns

After the initial boom and bust heyday of the "gold rush", Montana slowly began to garner the economic reputation that it has today - that of a producer of raw resources rather than a manufacturer of products for final consumption. Agriculture, mining and wood products still continue to determine economic health in Montana; although recreation and tourism do provide

[1] Those living in communities of at least 1,000 people.

Table 14. Human Population of Great Plains, Montana.

County	Total Persons	Urban Population[1]	Farm Operators
Big Horn	11,096	3,300	496
Blaine	6,999	2,683	493
Carbon	8,099	1,896	613
Carter	1,799	--	345
Cascade	80,696	65,670	787
Chouteau	6,092	1,693	825
Custer	13,109	9,602	376
Daniels	2,835	1,382	409
Dawson	11,805	5,978	546
Fallon	3,763	2,354	306
Fergus	13,076	7,104	810
Garfield	1,656	--	269
Glacier	10,628	4,914	363
Golden Valley	1,026	--	139
Hill	17,985	12,121	693
Judith Basin	2,646	--	345
Liberty	2,329	--	280
McCone	2,702	--	453
Musselshell	4,428	2,119	228
Petroleum	655	--	99
Phillips	5,367	2,367	513
Pondera	6,731	3,074	511
Powder River	2,520	--	346
Prairie	1,836	--	197
Richland	12,243	7,092	612
Roosevelt	10,467	3,074	703
Rosebud	9,899	4,029	350
Sheridan	5,414	2,476	642
Stillwater	5,598	1,439	435
Sweet Grass	3,216	1,690	284
Teton	6,491	1,798	645
Toole	5,559	3,142	351
Treasure	981	--	112
Valley	10,250	4,455	738
Wheatland	2,359	1,181	158
Wibaux	1,476	--	200
Yellowstone	108,035	80,759	1,024
TOTAL	401,866	237,392	16,696
PERCENT OF TOTAL		59%	4%

[1] Living in towns with 1,000 or more people.

seasonal incomes. Average total statewide income from 1975 through 1980 was about $3,858,103,000 of which 55% was spread across Great Plains Montana. Tables 15 and 16 show employment and the principle sources of income statewide for major sectors of the economy. Manufacturing is less important to the overall economy in Montana than the national average, and agriculture is clearly more important. The greater share of income derived from government sources can be basically attributed to the management of federal lands and military bases.

The economy of Eastern Montana is generally characterized by dryland grain farming, irrigated alluvial valleys, livestock production, energy production (oil, natural gas, and coal), retail trades, and services. The timber industry, tourism and metals mining are less important to the Great Plains area than to the western third of Montana. Table 17 demonstrates the employment in major sectors of the economy in Great Plains Montana and the Rocky Mountain area (145).

Agriculture provides a substantial portion of the total employment in the east, while manufacturing, trades, services, and government are less important than in the west. In most of the rural areas of Eastern Montana, agriculture is the lifeblood of personal income. Without it most of the small communities of Great Plains Montana would not be present.

On the Great Plains, agriculture has a large role in personal earnings. East of the Rocky Mountain foreland (Figure 6) agriculture accounts for just over one fourth of the total earnings. In the urban areas of Billings and Great Falls the economic picture is dominated by government and private non-farm earnings[1] (Table 18) (145).

In terms of relative importance of agricultural commodities, small grains made up the largest portion of income in 1981. From 1976 to 1981 cattle and calves accounted for 42.7% of the receipts with wheat and barley accounting for 41.8% (100). In some grain farming areas cash receipts from grains are the major source of agricultural earnings. For example in the Golden Triangle area, cash receipts from wheat alone account for two-thirds of the income from agriculture (100). Northeast Montana has a similar agricultural picture dominated by small grains farming. Table 19 shows the relative importance of ranching and farming in various parts of Great Plains Montana.

In most counties small grains are the most important cultivated crops (Table 20). Not shown in Table 20 are about 44,500 acres of sugar beets and 13,000 acres of dry beans that are harvested

[1] "Private non-farm earnings" includes manufacturing, mining, contract construction, transportation, commerce, public utilities, finance, insurance real estate and others.

Table 15. Employment in Selected Montana Industries (thousands of persons).

Industry	1960	1965	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	Change 1960 1970	Change 1970 1980
BASIC														
Agriculture	39.0	35.2	36.1	33.1	35.0	36.3	38.8	34.8	33.4	34.5	33.0	32.2	-2.9	-4.1
Mining	7.4	7.5	6.6	5.4	6.3	6.5	7.1	6.4	6.1	6.1	7.0	7.6	-0.8	.6
Metal	4.5	4.6	4.0	2.9	3.7	3.8	4.0	3.1	2.4	2.0	2.0	2.0	-0.5	-2.5
Coal	n/a	n/a	n/a	0.2	0.3	0.3	0.4	0.7	0.8	0.9	1.2	1.2	n/a	1.0
Oil & Gas	2.2	1.8	1.8	1.6	1.6	1.6	1.8	1.8	2.1	2.6	2.9	3.3	-0.4	1.5
Other Mining	0.7	1.1	0.8	0.7	0.7	0.8	0.9	0.8	0.8	0.6	.9	1.1	0.1	.3
Manufacturing	20.4	22.2	23.9	24.0	24.5	24.8	24.5	22.1	23.7	24.2	26.3	26.9	3.5	-.3
Wood Products	7.3	8.6	8.2	8.7	9.2	9.8	9.5	8.1	9.1	9.3	10.7	10.9	0.9	.3
Primary Metal	3.8	3.6	4.7	4.1	3.9	3.4	3.4	3.3	3.3	3.2	3.2	3.3	0.9	-2.3
Food Products	4.3	4.3	4.3	4.2	4.2	4.3	4.1	3.5	3.7	4.0	4.0	4.1	0.0	-.3
Other Mfg.	5.0	5.7	6.7	7.0	7.2	7.3	7.5	7.2	7.6	7.7	8.4	8.6	1.7	2.0
Railroad	9.0	7.5	6.6	6.4	6.4	6.3	6.5	6.1	6.1	6.3	6.8	7.4	-2.4	.5
Federal Government excluding military	9.9	12.1	11.9	11.9	12.3	12.2	12.9	14.2	13.7	14.1	13.6	13.3	2.0	1.1
TOTAL BASIC	85.7	84.5	85.1	82.7	82.6	86.1	89.8	83.6	83.0	85.2	86.7	87.4	-0.6	-2.2
NONBASIC														
Transportation, Communications & Utilities, excluding Railroad	10.0	10.0	10.8	11.3	11.5	12.4	13.0	12.9	13.4	13.9	14.9	15.8	0.8	5.5
Construction	11.0	12.0	11.0	11.7	11.4	13.0	13.5	12.1	13.8	15.6	16.7	15.3	0.0	4.6
Trade	40.5	42.9	48.3	50.1	53.5	56.3	58.8	59.1	63.7	66.3	72.2	74.5	7.8	26.6
Services*	30.0	33.3	41.8	43.8	46.3	49.8	52.4	54.5	58.6	60.7	64.8	67.4	11.8	26.9
State & Local Government	28.6	33.8	40.7	42.5	43.1	43.2	45.3	50.7	52.0	56.5	58.1	56.8	12.1	17.3
Non-Farm Proprietors & Other	30.2	30.0	23.7	22.9	28.9	27.8	29.1	29.1	27.5	24.8	32.6	33.8	-6.5	10.6
TOTAL NONBASIC	150.3	162.0	176.3	182.3	194.7	202.5	212.1	218.4	229.0	237.8	259.3	263.6	26.0	91.5
TOTAL	236.0	246.5	261.4	265.0	277.3	288.6	301.9	302.0	312.0	323.0	346.0	351.0	25.4	89.3

Adopted from reference 139. * Includes Employment in Finance, Insurance, and Real Estate.

Table 16. Relative Contribution of Major Industries to the Montana Economy, 1974-79[1].

Sector	Percent of Total Income	
	Montana	USA
Farming	8.4	3.1
Mining	4.0	1.5
Construction	8.0	6.0
Manufacturing	10.6	26.0
Transportation/ Utilities	10.3	7.5
Trade	18.3	16.7
Finance	4.3	5.6
Services	14.8	16.6
Government	21.5	17.1

[1] Adopted from reference 145.

Table 17. Percent of Employment by Region in Montana[1].

Sector	Rocky Mountain Area	Great Plains Montana
Agriculture	6.1	17.9
Mining	1.7	3.5
Construction	4.2	4.0
Manufacturing	10.3	3.3
Transportation/ Communications	6.2	6.0
Trade/Service	49.8	46.3
Government	21.7	19.0

[1] Adopted from reference 145.

Table 18. Percentage of Net Personal Income From Major Sources and Total Gross Personal Income by County.[1]

County	Farm	Non-Farm	Government	Total Gross Personal Income (1000)[3]
Big Horn	13.3	70.4	16.3	62,019
Blaine	14.8	55.9	29.2	22,643
Carbon	23.6	56.7	19.7	23,547
Carter	36.0	46.1	17.8	5,198
Cascade	1.9	69.4	28.8	466,493
Chouteau	46.9	38.8	14.4	27,463
Custer	7.0	68.4	24.6	67,080
Daniels	45.7	42.3	12.1	15,495
Dawson	5.4	81.6	13.0	61,401
Fallon	8.7	78.1	13.2	19,401
Fergus	13.2	65.8	21.0	51,863
Garfield	54.2	28.7	17.1	7,032
Glacier	15.0	66.2	18.8	66,302
Golden Valley	58.2	21.3	20.5	2,838
Hill	12.2	72.3	15.5	98,322
Judith Basin	49.8	28.4	21.8	8,942
Liberty	60.7	27.1	12.2	17,199
McCone	33.0	55.1	11.9	13,083
Musselshell	11.6	77.1	11.3	18,323
Petroleum	67.7	18.8	13.5	3,042
Phillips	20.5	61.6	17.9	18,496
Pondera	37.7	49.9	12.4	33,723
Powder River	25.7	52.0	22.2	10,119
Prairie	31.5	51.8	16.7	7,178
Richland	17.2	73.4	9.4	61,979
Roosevelt	14.4	63.9	21.7	43,457
Rosebud	5.0	82.1	12.9	52,988
Sheridan	27.5	60.3	12.2	26,313
Stillwater	20.6	61.3	18.1	15,298
Sweet Grass	21.2	57.8	20.9	9,983
Teton	42.3	43.9	13.9	31,337
Toole	36.3	53.5	10.2	47,830
Treasure	37.8	45.6	16.6	3,557
Valley	7.7	72.0	20.3	50,433
Wheatland	29.1	58.5	12.4	11,926
Wibaux	28.1	49.7	22.2	4,494
Yellowstone	1.8	84.8	13.4	640,298
AVERAGE	26.6	56.5	16.9	2,126,758

[1] Files of Census and Economics Information Center, Montana Department of Administration.

[2] Includes receipts from mining, construction, manufacturing, transportation and public utilities, wholesale and retail trade, finance, insurance, real estate and services.

[3] Average of years 1975 through 1980 for income of laborors and proprietors.

Table 19. Cash Receipts From Livestock and Crop Production by District in Montana in 1980.

District	Total Cash Receipts (1000 dollars) Livestock and Livestock Products	Crops
North Central[1]	111,504	258,715
North East[2]	105,196	151,890
Central[3]	167,234	74,665
South Central[4]	176,470	73,925
South East[5]	97,217	40,092

1 Blaine, Chouteau, Glacier, Hill, Liberty, Phillips, Pondera, Teton, Toole Counties.

2 Daniels, Dawson, Garfield, McCone, Richland, Roosevelt, Sheridan, Valley Counties.

3 Broadwater, Cascade, Fergus, Golden Valley, Judith Basin, Lewis & Clark, Meagher, Musselshell, Petroleum, Wheatland Counties.

4 Big Horn, Carbon, Park, Stillwater, Sweet Grass, Treasure, Yellowstone Counties.

5 Carter, Custer, Fallon, Powder River, Prairie, Rosebud, Wibaux Counties.

primarily along the Yellowstone River. Figures 9 through 14 illustrate by county the acreage harvested for winter, spring and durum wheat, barley, oats, and alfalfa hay in 1981. (Figures 9 through 14 courtesy of the Montana Crop and Livestock Reporting Service).

Despite rapid inflation during the 1970's the prices received by farmers for raw grain commodities did not increase substantially after 1972 (Table 21). The average selling price for a bushel of wheat in 1981, for example, was $4.00, the highest price since 1973 when a bushel brought $4.24 (100). Between those years the price received for wheat fluctuated an average of $0.53 per bushel from year to year, and up to $1.16 in a single year. This unpredictability coupled with increasing costs of production under present farming schemes may be partly responsible for the recent reduction in the number of farms.

The number of farms in Montana peaked in 1920 at about 57,700 and then began a steady decline starting about 10 years later. In 1982 there were about 24,000 farms in Montana. Attendant with decrease in farms has been an increase in farm size. The average farm in Montana now covers about 2,588 acres which is about 800 acres larger than in 1950 (100). In drier areas where soils are poorer and livestock grazing is the primary resource, farms are

Table 20. Acreages of Selected Crops Harvested in 1981 From Counties of Great Plains Montana.

	ACRES (Thousands)						
County	Winter Wheat	Spring Wheat[1]	Barley	Oats	Hay	Corn	Pasture/ Rangeland[2]
Big Horn	110.0	6.8	21.2	0.3	70.0	4.2	2367.2
Blaine	94.0	106.4	27.0	4.3	40.0	1.2	1876.7
Carbon	16.7	4.2	11.9	0.8	58.0	5.6	475.2
Carter	35.1	9.7	7.2	2.6	60.0	0.8	1355.0
Cascade	91.0	604.5	60.9	1.7	66.0	0.3	905.0
Choteau	291.0	192.7	180.6	2.9	52.0	0.1	1076.7
Custer	42.8	11.6	9.0	1.6	50.0	7.6	2106.3
Daniels	0.4	264.0	10.8	2.9	19.0	--	326.4
Dawson	95.0	83.1	21.5	4.0	39.0	4.8	872.9
Fallon	31.0	42.5	6.2	2.8	49.0	1.2	D
Fergus	115.0	21.6	101.2	2.9	120.0	0.1	1397.2
Garfield	36.0	76.6	24.0	6.3	17.0	0.8	1818.7
Glacier	15.5	107.3	82.7	2.5	25.5	--	1247.7
Golden Valley	31.0	1.1	7.5	2.0	14.5	0.4	534.1
Hill	255.0	312.5	35.7	3.7	23.0	0.2	562.7
Judith Basin	58.0	13.5	62.4	3.4	31.0	0.2	540.5
Liberty	111.0	156.0	36.1	1.0	8.5	0.2	343.9
McCone	112.0	126.8	22.8	3.1	21.0	0.4	815.2
Musselshell	24.0	4.9	8.2	0.7	23.0	0.9	1021.5
Petroleum	7.6	10.0	5.2	0.5	19.0	0.1	657.7
Phillips	38.0	116.3	26.5	7.2	75.0	0.4	1594.1
Pondera	114.0	85.6	96.5	3.0	21.0	--	325.5
Powder River	30.7	2.6	5.9	2.3	61.0	0.2	1382.4
Prairie	45.1	2.3	6.1	1.5	18.0	4.1	591.2
Richland	70.0	110.5	22.0	3.9	40.0	10.8	643.9
Roosevelt	18.0	350.8	16.4	8.0	38.0	1.4	709.8
Rosebud	53.6	15.0	13.4	1.0	37.0	5.3	2786.9
Sheridan	3.2	318.7	14.6	8.0	31.0	0.1	367.4
Stillwater	61.6	1.9	19.1	0.8	49.0	2.7	629.6
Sweetgrass	9.8	0.7	3.9	1.4	54.0	--	727.8
Teton	99.0	44.5	85.7	2.0	63.0	--	667.9
Toole	116.5	185.4	44.7	1.1	12.0	--	426.8
Treasure	5.9	1.6	2.7	0.7	18.0	4.9	543.2
Valley	26.4	302.2	23.1	3.0	50.0	1.9	1356.0
Wheatland	27.0	5.4	19.3	0.7	24.0	--	723.6
Wibaux	15.7	56.6	4.6	1.5	25.0	1.3	361.2
Yellowstone	105.0	7.0	22.2	2.5	53.0	19.9	1009.6

[1] Includes durum wheat. [2] 1978 data (reference 160). D - data unavailable

Figure 9. WINTER WHEAT

Acreage Harvested, 1981

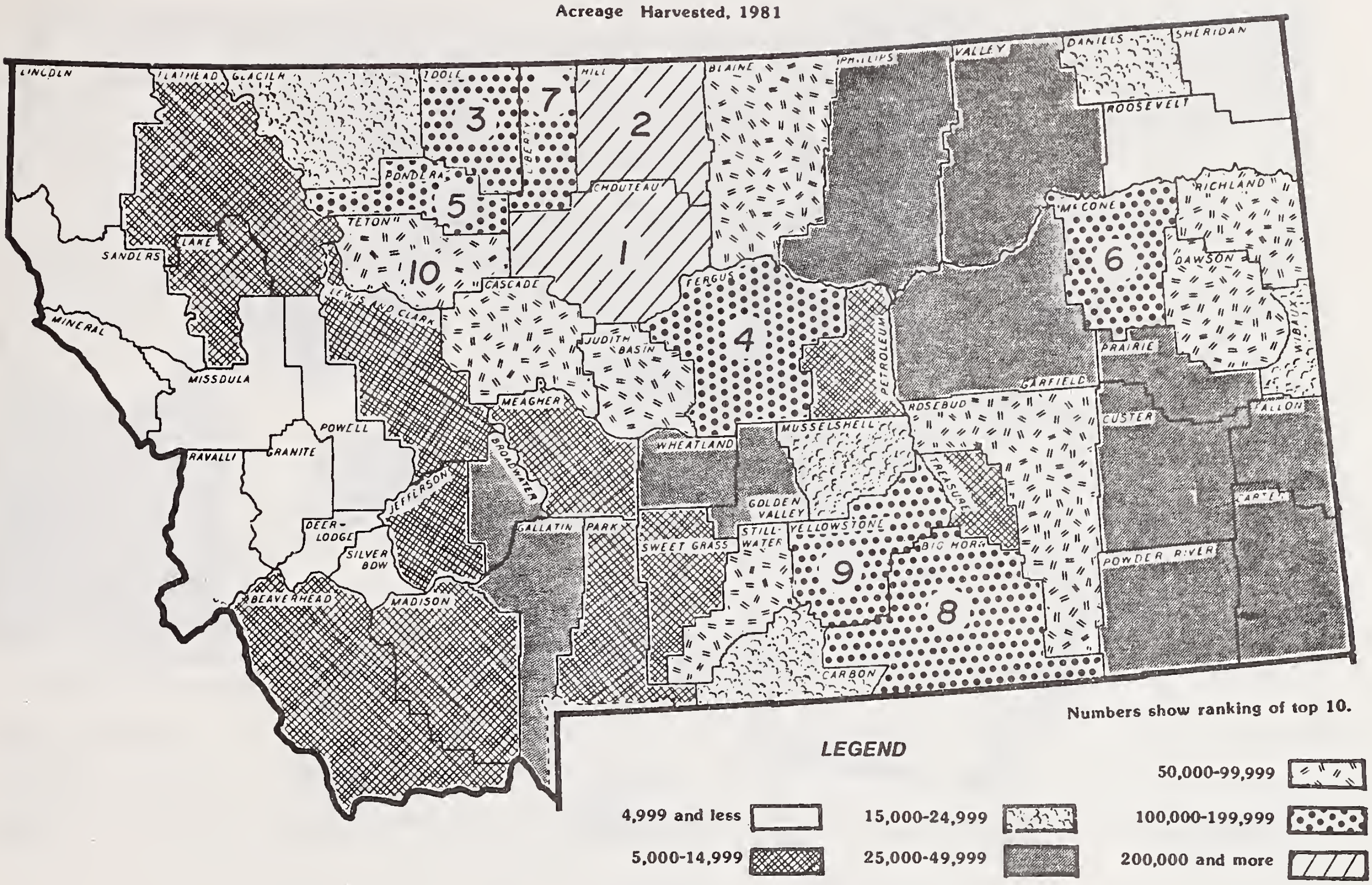
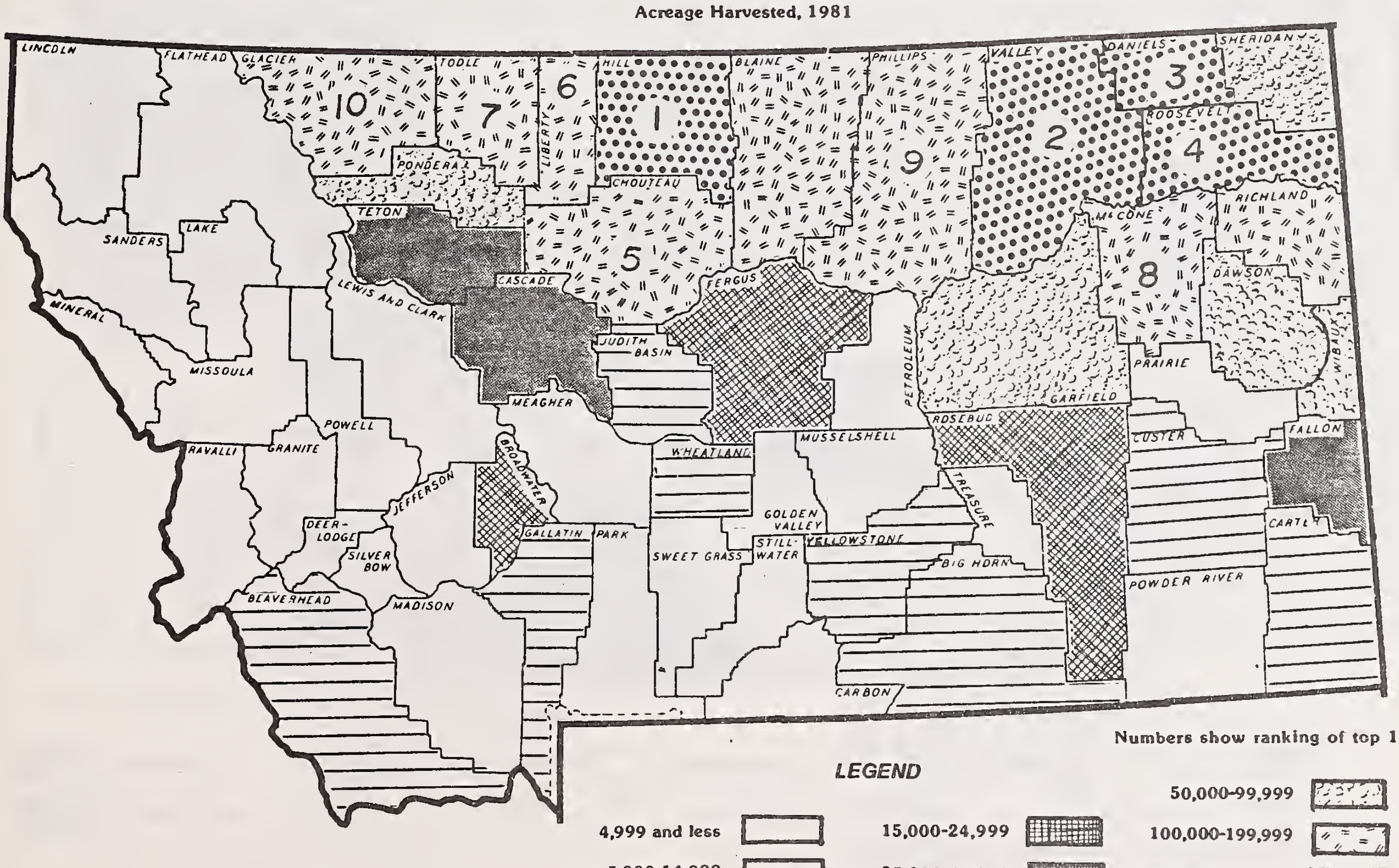


Figure 10. SPRING WHEAT, EXCLUDING DURUM

Acreage Harvested, 1981



Adopted from Ref. 100

Figure 11. DURUM WHEAT

Acreage Harvested, 1981

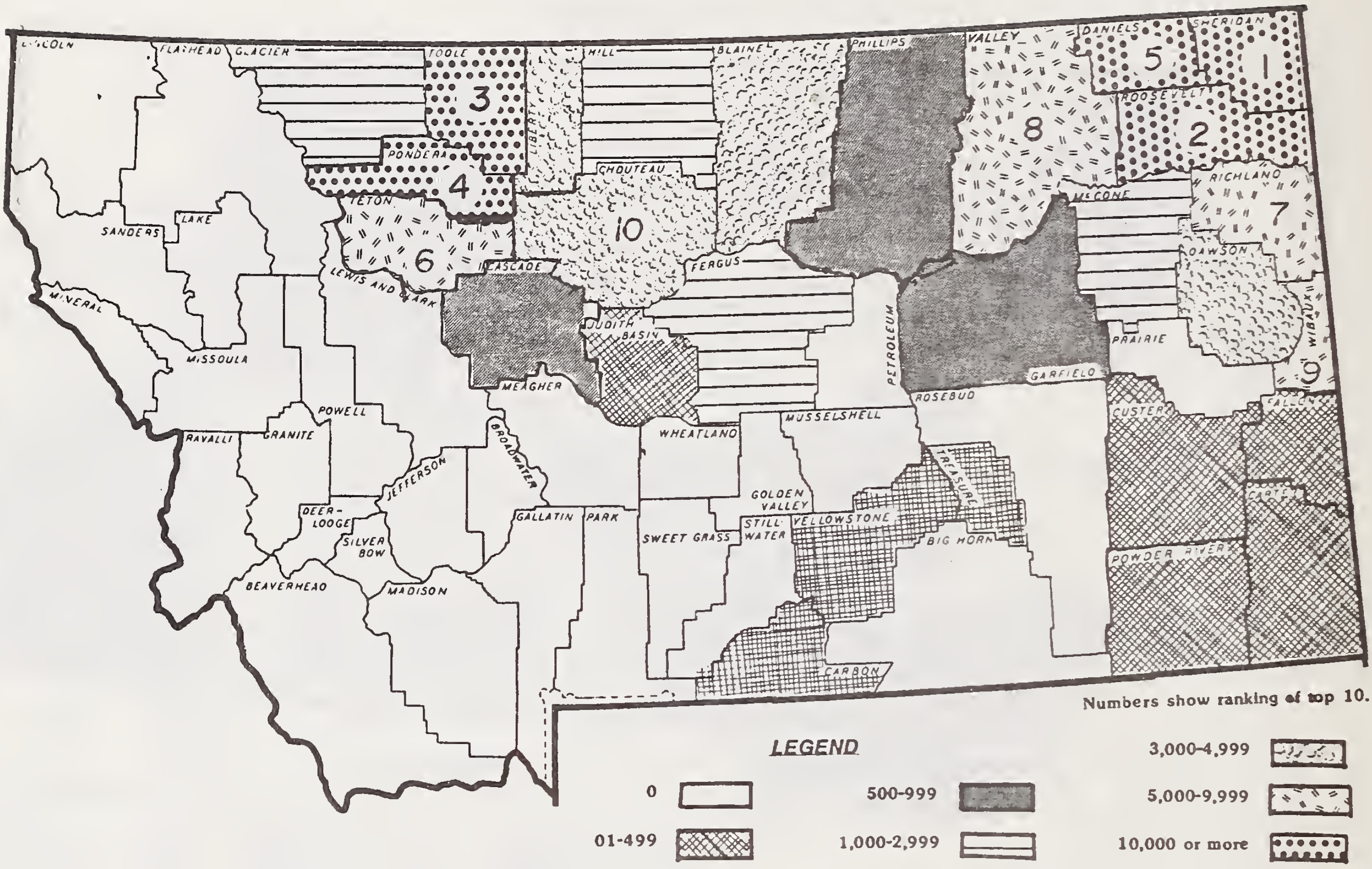
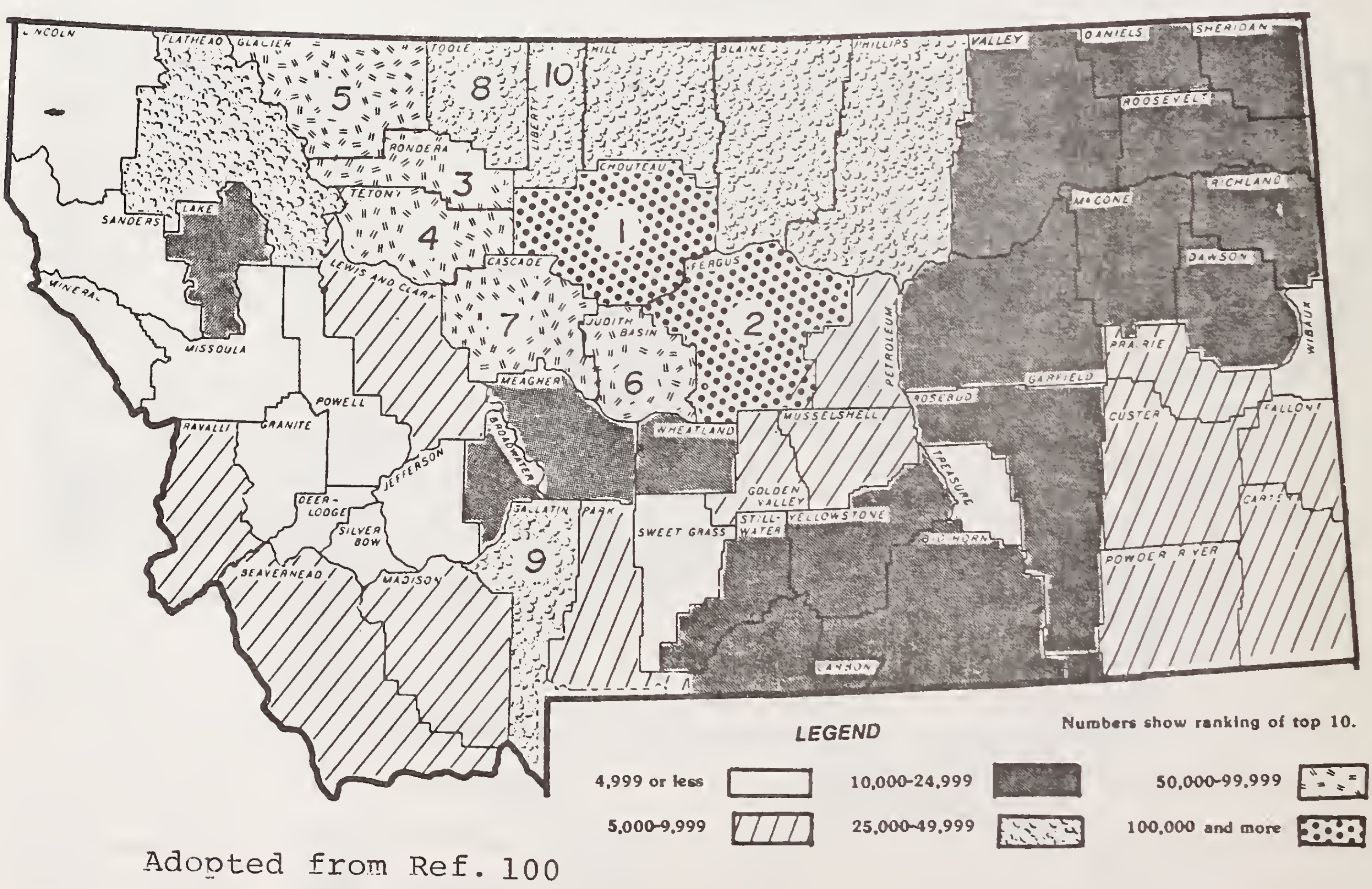


Figure 12. BARLEY

Acreage Harvested, 1981



Adopted from Ref. 100

Figure 13. **OATS**

ACREAGE HARVESTED, 1981

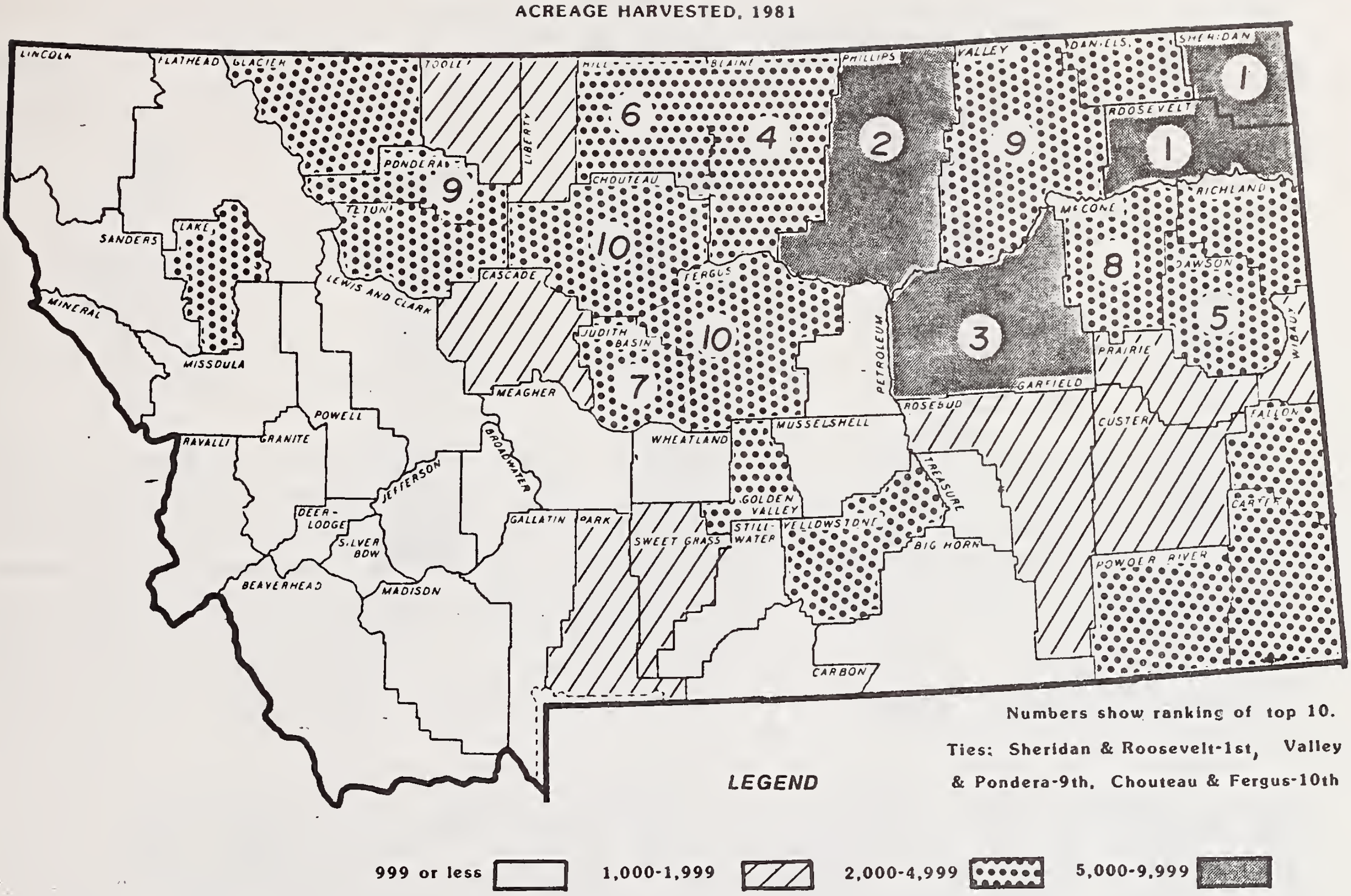
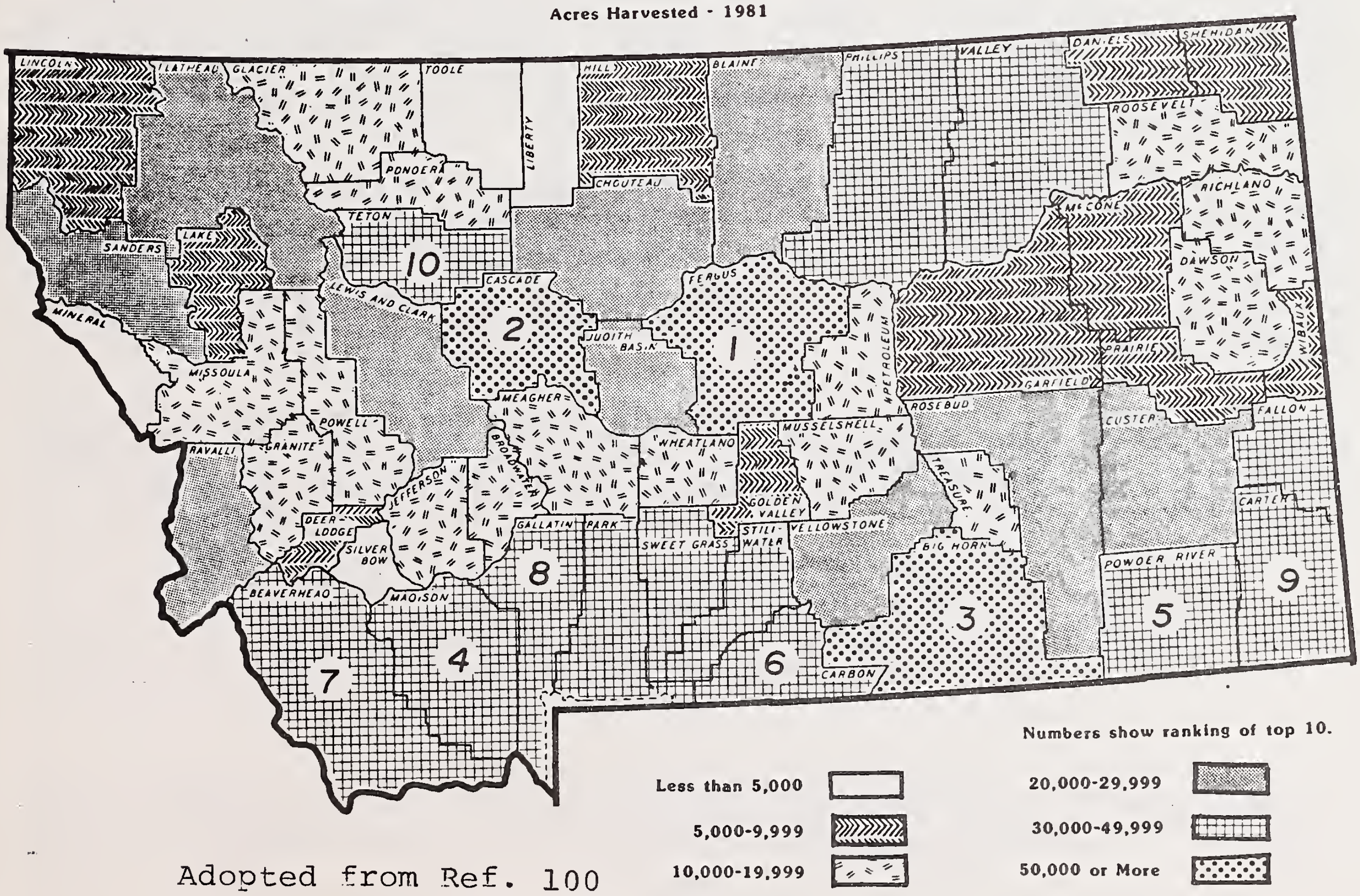


Figure 14. **ALFALFA HAY**

Acres Harvested - 1981



Adopted from Ref. 100

Table 21. Prices Received by Montana Farmers for Selected Commodities From 1972 to 1981.

Year	Winter Wheat	Spring Wheat[1]	Barley	All Hay
1972	$1.87/bu.	$1.90/bu.	$1.22/bu.	$32.00/T
1973	4.18	4.16	2.17	57.00
1974	3.98	4.57	2.61	45.50
1975	3.34	4.01	2.10	42.00
1976	2.85	3.35	2.03	43.63
1977	2.21	2.41	1.79	52.63
1978	2.64	2.73	1.78	48.83
1979	3.21	3.21	1.90	51.29
1980	3.72	3.94	2.32	60.89
1981	3.89	4.03	2.65	53.09
AVERAGE	$3.19/bu.	$3.43/bu.	$2.06/bu.	$48.69/T

[1] Excludes durum wheat.

even larger. For example, in Garfield County, a livestock production area, the average farm size is 7,636 acres (160). In the Golden Triangle winter wheat area, average farm size ranges from about 1,500 to 3,000 acres (depending on the county).

The majority of farms in Montana are private operations, either family or individual. These farms which accounted for 81% of all farms in 1978 have undergone a steady decline. Incorporated farms comprised 8% of all farms in 1978 but controlled 26% of the total harvested cropland.

Those farms growing wheat and barley and, in particular, winter wheat are where endrin can be used to control cutworms. In 1978, about 10,749 farms or 44% of all Montana farms had land in wheat production and 8,363 or 34% grew barley. Of these grain farms, the majority were located in Great Plains Montana (9,786 wheat; 6,455 barley farms).

In 1978, about 7,628 Montana farms were classed as "cash grain", meaning that 50% or more of the farm income was from grain sales. Table 22 shows the average income from grain sales for these farms.

Table 22. Cash Grain Farms in Montana, 1978.

Crop	Farms	Average Gross Grain Income Per Farm
Wheat	7086	$42,100
Barley	3996	14,600
Oats	1086	3,400

Wheat farming provides a basic source of income into Montana's economy. As measured by cash receipts from farm commodities, wheat contributes between 20 and 50 percent of the agricultural revenue. Besides benefiting agricultural communities, wheat farming stimulates most sectors of the Montana economy as does agriculture in general. The businesses of small farming communities may typically consist of a few cafe's, bars, and stores, an implement dealer and grain elevator, and other service industries that derive a good deal of their economic support from farming. Most of the gross receipts from crop sales are spent locally for services, trade items, real estate and finance, taxes, and other expenditures. It was estimated in 1976 that for every $1,000 revenue from wheat sales, an additional $1,937 of business activity was generated in the Montana economy (70).

Production of Wheat and Barley

Greater than 90% of Montana's wheat production occurs on non-irrigated land by "dryland farming". Nearly all the winter wheat is grown in this fashion. More than 90% of small grains production occurs under summer fallow cropping practices, taking advantage of the soil moisture accumulated during the fallow years. Summer fallow crops characteristically yield 5 or 6 bushels more per acre than continuously cropped dryland acreages.

Grain farming requires high investment costs which often result in low returns. Under present farming practices, grain production is made profitable by farming large acreages so that the low return on investment is offset by farming larger units. From 1978 to 1981, for example, dryland winter wheat averaged 24 bushels per acre for a gross return of about $81.00 per acre. In the same period, dryland spring wheat averaged 24 bushels for a gross return of about $86.00 per acre, statewide. Despite these low returns, wheat continues to be the staple crop for many farmers, probably because of established markets and service industries, and growing conditions. Tables 23 and 24 give production costs and gross returns for winter wheat and dryland barley in several counties in 1982.

An example of typical wheat production expenses are presented in Tables 25 and 26 for Chouteau and McCone Counties. A very small portion of production costs are due to insecticide use. In the

example from Chouteau County, about 0.5% of the production costs for wheat was due to insecticide use, and none, for barley. In McCone County about 1.4% of winter wheat production cost was for insecticide. The 1978 Census of Agriculture reported that insecticide use occurred in 2,607 farms or 10.7% of all Montana farms. In 1978 insecticide use on crops other than hay occurred on 2,086 farms or 8.5% of all farms.

Table 23. 1982 Costs and Receipts for Winter Wheat Production[1].

	Production Costs			
County	Summer Fallow[2]	Crop Year[3]	Real Estate[4]	Gross Receipts[5]
Blaine	$69.36	$ 99.26	$26.25	$127.98
Cascade	75.77	105.66	26.25	160.27
Chouteau	85.62	107.50	38.50	154.43
Glacier	56.26	90.55	26.25	143.93
Judith Basin	77.30	102.57	38.50	135.76
Liberty	67.81	127.64	26.25	147.82
McCone	68.55	100.18	24.50	101.14
Phillips	69.07	116.29	26.25	97.25
AVERAGE	$71.22	$106.21	$29.09	$133.57

[1] References 56, 57, 58, 59, 60, 61, 62.
[2] Costs of summer fallow are part of the costs of most dryland winter wheat production.
[3] Excludes real estate.
[4] Interest on land investment.
[5] Calculated from 1981 average yields and prices (11).
NOTE: Acreages evaluated average 810 acres (range 500-1000) per county for summer fallow and 448 acres (range 100-880) for winter wheat.

Table 24. 1982 Costs and Receipts for Barley Production[1].

County	Production Costs			Gross Receipts[5]
	Summer Fallow[2]	Crop Year[3]	Real Estate[4]	
Blaine	$69.36	$101.46	$26.25	$ 96.46
Cascade		127.93[5]	26.25	128.00
Chouteau	85.62	110.61	38.50	116.60
Glacier	56.26	99.19	26.25	126.94
Judith Basin	77.30	99.59	38.50	98.58
Liberty	67.81	122.71	26.25	113.16
McCone	68.55	111.01	24.50	81.89
Phillips	69.07	125.74	26.25	91.43
AVERAGE	$61.75	$112.28	$29.09	$106.63

1 References 56, 57, 58, 59, 60, 61, 62.
2 Costs of summer fallow are part of the cost of most barley production.
3 Excludes real estate.
4 Interest on land investment.
5 Recrop barley.
6 Calculated from 1981 average yields and prices (11).
NOTE: Acreages evaluated average 233 acres (range 100-600) per county.

Table 25. Production Expenses in 1982 for Growing Winter Wheat and Dryland Barley in Chouteau County (58).

Expense	Winter Wheat	Barley
Variable Costs		
Seed	$ 3.82/ac	$ 3.25/ac
Nitrogen	1.50	1.50
Phosphate	5.60	5.60
Insecticide	0.70	--
2,4-D	1.46	1.46
Crop Insurance	5.00	5.00
Machinery	16.54	17.13
Tractors	2.72	4.18
Labor	5.23	5.89
Interest on Op. Cap.	2.85	1.58
Miscellaneous	4.67	4.79
Fixed Costs		
Machinery	43.98	44.67
Tractors	4.85	6.99
Taxes	3.27	3.27
Interest	38.50	38.50
Improvements	5.31	5.31
TOTAL	$146.00/ac	$149.11/ac

Table 26. Production Expenses in 1982 for Growing Winter Wheat and Dryland Barley in McCone County (62).

Expense	Winter Wheat	Barley
Variable Costs		
Seed	$ 3.82/ac.	$ 4.55/ac.
Nitrogen	2.25	2.25
Phosphate	4.60	4.60
2,4-D	1.46	1.46
Tordon	2.01	2.01
Crop Insurance	7.50	7.50
Insecticide	1.75	--
Interest on Op. Cap.	3.21	2.07
Machinery	14.80	18.59
Tractors	2.56	3.91
Labor	4.84	5.85
Miscellaneous	4.42	4.89
Fixed Costs		
Machinery	35.64	39.70
Tractors	4.40	6.72
Taxes	2.26	2.26
Interest on Land	24.50	24.50
Improvements	4.66	4.66
TOTAL	$124.68/ac.	$135.52/ac.

D. Recreation

Recreational use of natural resources provides a certain amount of economic stimulus to local economics and, in the case with regulated recreation, to government coffers. Actions that interrupt the amount of recreation may well result in economic impacts.

Great Plains Montana, while having appeal to those who live there, and beauty to those who understand or appreciate the plains environment, is not noted for drawing recreationists. A certain amount of fishing, boating, and related kinds of recreation occur on rivers and several reservoirs. The Missouri River from Fort Benton to Fort Peck Dam is an important recreational area for boaters, campers and fishermen. From Fort Benton to Fred Robinson Bridge, the Missouri River is part of the National Scenic Rivers system. Hunting is an important form of recreation in Eastern Montana and deserves consideration when game animals may be contaminated with endrin.

The primary game species of the plains are pronghorns, mule deer, white-tailed deer, pheasants, gray partridge, sharp-tailed grouse, sage grouse, ducks, and geese. All of these species, except sage grouse, can commonly be associated with farmlands which may be used as a food source or for cover (Table 27).

Table 27. The Occurrence of Game Animals on Farms and Ranches in Montana[1].

Species	Percent of Farms Inhabited
Mule Deer	79
White-tailed Deer	77
Pronghorn	60
Pheasants	74
Hungarian Partridge	85
Sharp-tailed Grouse	56
Sage Grouse	39
Geese	49
Ducks	80

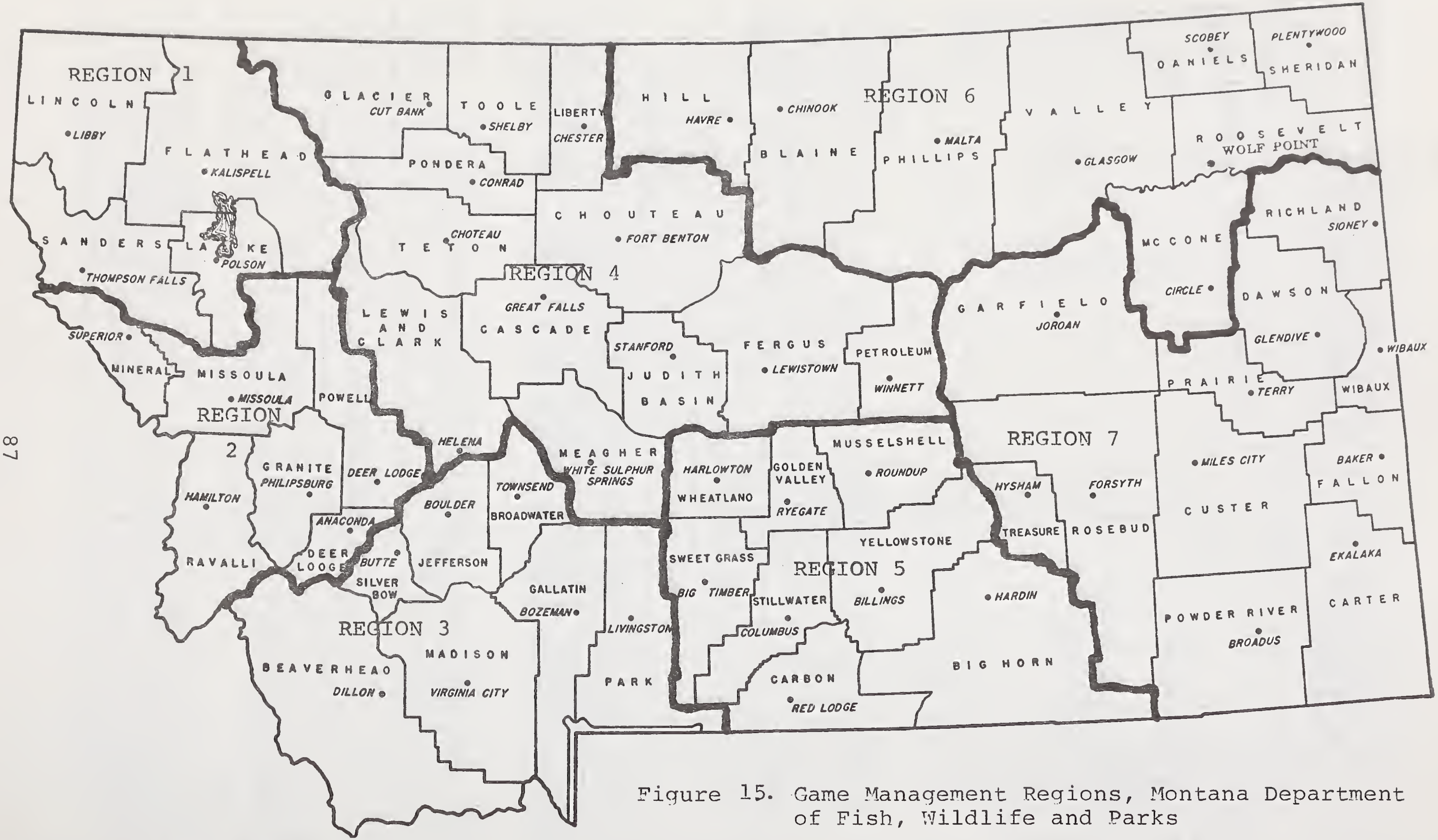
[1] Based on a survey of 633 farms (103).

A large portion of the wildlife harvest occurs on private lands - 78% of all antelope, 77% of white-tailed deer, and 53% of mule deer (105). Also the majority of pheasant, gray (hungarian) partridge, sharp-tailed grouse, and sage grouse hunting occurs on private lands. Private agricultural lands provide a large share of goose hunting but duck hunting occurs more on public lands. Because of the feeding habits of waterfowl, the possibility of a bagged bird having a previous association with cultivated grains is high. Tables 28 and 29 show the numbers of deer, antelope, and upland game birds harvested and the total number of hunter days by Fish, Wildlife and Parks Region (see Figure 15). While these figures are not current they do give a comparison of the amount of hunting that occurs by region. Tables 30 and 31 show the trends in game bird license sales, days hunted, and birds harvested from 1976 to 1981.

Table 28. Big Game[1] and Upland Game[2] Bird Harvest by Region in 1975 and 1976 (105).

	Harvest by Region (1000 animals)						
	1	2	3	4	5	6	7
Mule Deer	1.3	2.6	4.6	8.2	3.6	2.8	4.2
White-tailed Deer	3.3	1.2	0.5	3.3	1.0	2.2	4.8
Pronghorn	--	--	1.1	2.6	4.6	1.7	6.3
Sharp-tailed Grouse	--	--	1.3	26.0	10.1	45.0	28.0
Sage Grouse	--	--	5.2	8.5	9.8	9.7	8.3
Pheasants	5.5	0.9	1.5	13.9	6.4	15.0	13.4
Gray Partridge	1.8	0.6	2.0	23.0	6.4	16.3	4.1

[1] 1976
[2] 1975



No. 1052 — County Outline Map
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Figure 15. Game Management Regions, Montana Department of Fish, Wildlife and Parks

Table 29. Total Hunter Recreation Days for Selected Game Species by Region in 1975[1] and 1976[2].

	Recreation Days (1000 days) by Region						
	1	2	3	4	5	6	7
Mule Deer	42.0	110.2	155.0	110.4	47.7	22.9	32.7
White-tailed Deer	108.0	51.8	17.2	43.0	12.7	18.1	36.8
Pronghorn	--	--	4.5	10.5	14.3	7.9	25.5
Sharp-tailed Grouse	--	--	1.2	12.6	5.3	15.5	13.2
Sage Grouse	--	--	4.9	5.3	6.2	7.6	5.9
Pheasants	8.8	2.2	3.1	14.5	8.0	13.3	12.9
Gray Partridge	2.2	0.8	3.9	15.6	5.8	9.6	5.6

[1] 1975 is big game data.
[2] 1976 is upland bird data.

Table 30. Summary of the Numbers of Resident and Non-resident Game Bird Hunting Licenses Issued in Montana, 1976-1981.

License Year	Resident[1]	Non Resident[2]	Total
1976	62,493	3,432	65,925
1977	67,817	3,200	71,017
1978	66,951	3,151	70,102
1979	67,408	3,431	70,839
1980	67,109	2,638	69,747
1981	55,482	2,458	57,940
Average	66,355	3,170	69,526

[1] Includes sportsman, bird-adult and bird-youth license.
[2] Includes bird license only.
Data provided by the Montana Department of Fish, Wildlife & Parks.

Table 31. Summary of the Numbers of Upland Game Bird Hunters Afield, Days Hunted, and Birds Harvested in Montana, 1976-1981.

Year	No. Hunters Afield	Upland Birds Harvested[1]				Days Hunted
		Prairie Grouse[2]	Forest Grouse[3]	Farmland Exotics[4]	Total	
1976	50,597	188,156	107,999	193,242	489,397	360,663
1977	53,170	129,938	131,989	208,042	469,969	363,777
1978	51,222	139,869	137,340	197,832	475,041	349,314
1979	57,313	188,179	191,305	170,886	550,370	426,879
1980	51,756	109,813	75,088	147,352	332,253	354,413
1981	37,459	82,706	53,817	129,905	266,428	224,707
Avge.	52,811	151,191	127,744	183,470	463,405	371,009

[1] Numbers given are point estimates, projected from a portion of hunters who purchased game bird licenses.
[2] Includes sage grouse and sharp-tailed grouse.
[3] Includes blue grouse, ruffed grouse, and spurce grouse.
[4] Includes pheasant, gray partridge, and chukar partridge.
Data provided by the Montana Department of Fish, Wildlife & Parks.

Table 32 gives statewide average license sales, total hunter days and waterfowl harvest from 1976 to 1981.

Table 32. Summary of the Numbers of Waterfowl Hunting Stamps Sold, Hunters Afield[1], Hunter Days[1], and Waterfowl Harvested in Montana, 1976-1981.

Year	No. Stamps Sold	No. Hunters Afield		Total Days Hunted		No. Waterfowl Harvested	
		Ducks	Geese	Ducks	Geese	Ducks	Geese
1976	30,114	23,680	13,950	148,237	69,750	215,249	13,406
1977	29,858	23,403	13,597	140,650	69,073	217,023	14,635
1978	30,401	21,832	12,517	126,625	69,958	206,703	14,443
1979	28,504	24,868	14,667	152,689	76,268	245,061	19,620
1980	27,446	21,284	13,976	157,655	82,506	208,153	17,257
1981	21,336	12,043	7,568	80,091	46,540	130,735	14,010
Avge.	29,265	23,013	13,741	145,171	73,511	218,438	15,872

[1] Numbers given are point estimates, projected from a portion of hunters who purchased game bird licenses each year.
Data provided by the Montana Department of Fish, Wildlife & Parks.

Data from the U.S. Fish and Wildlife Service gives some indication that a greater portion of waterfowl hunting in Montana occurs in the west (Pacific flyway) compared to the east (Central flyway) (165). Total hunter days from 1971 to 1980 averaged 132,201 in the west and 44,826 in the east. The average numbers of geese harvested were slightly higher from the Western flyway (4577-E, 7948-W) while a substantially greater number of ducks were harvested in the west (41,248-E, 128,362-W). A 1980 survey (159) estimated the number of migratory bird hunters by wildlife management region (Table 33).

Table 33. Waterfowl Hunter Days in Each Wildlife Management Region in Montana in 1980.

Region	Hunter Days	Percent of Total
1	25,200	15.6
2	12,600	7.8
3	48,200	29.9
4	43,400	26.9
5	9,300	5.8
6	21,900	13.6
7	400	0.2

Economics of Hunting

Revenues generated by hunting are a small but significant portion of the income generated from basic industries. A recent survey estimated that a total of 192,700 people hunted in Montana in 1980 (165). Of these 152,800 or 79.3% were residents and 39,900 or 20.7% were nonresidents. These hunters spent a total of 2,247,600 days hunting in Montana. Of this 1,920,100 or 85.4% was by residents and 327,500 or 14.6% was by nonresidents. The total expenditures by all hunters in 1980 amounted to $37,968,000, of which $20,857,000 or 54.9% was from residents and $17,111,000 or 45.1% from nonresidents (165). Using the above figures the average total amount of money spent per day by a hunter regardless of the species being hunted would be:

All hunters - $16.89
Residents - 10.86
Nonresidents - 52.25

Hunting expenses vary depending upon the quarry. A 1980 survey (165) estimated expenses of hunters, 16 years of age and older, depending on the species being hunted (Table 34).

Table 34. Expenditures of Hunters in Montana in 1980 Regardless of Residency Status (165).

Hunter	Statewide Total	Per Hunter	Per Day
Small Game[1]	$ 5,114,000	$ 92.33	$16.21
Migratory Bird	3,282,000	107.67	21.45
Big Game	32,985,000	229.44	29.04

[1] Includes upland game birds.

A 1980 survey in Wyoming estimated hunter expenditures for various game species (Table 35). These estimates were higher than those of the survey conducted federally (Table 34).

Table 35. Expenses Per Hunter Day in Wyoming in 1980 Depending Upon the Game Species (125).

Type of Hunter	Resident Expenditure/Day	Nonresident Expenditures/Day
Deer	$44.48	$77.09
Bird and Waterfowl	33.35	61.60
Small Game	21.22	44.04

Some of the expenditures by nonresident hunters occur outside Montana in the form of equipment purchases, transportation, and some food and lodging. Even though nonresident hunters spend more per day, not all this benefits the Montana economy. It can be assumed however that the average value per hunter day to the Montana economy is higher for nonresidents than for residents.

Of the $37,968,000 spent in Montana during 1980 by hunters, about 3% was for licenses and other regulatory fees (165). The remainder accounted for about 0.8% of the total unadjusted personal income of $4,792,481,000 generated from major sources in Montana in 1980 (101). The expenditures of hunters of just small game and migratory birds accounted for about 0.2% of the total unadjusted personal income in Montana. These estimates for Montana probably are high because they do not account for a significant portion of expenditures that occur outside of Montana by nonresident hunters in the way of purchases of equipment and supplies, and some transportation costs. Hunters expenditures are broken down into major categories in Tables 36 and 37.

Table 36. Average Expenditures Nationally Per Hunter in 1980 (165).

Expenditures	Type of Hunting Big Game	Small Game[1]	Migratory Bird
TOTAL	$236.29	$134.56	$120.12
Food	56.55	27.19	26.96
Lodging	7.76	2.41	3.36
Transportation	58.03	40.58	35.45
Guide Fees	2.24	0.11	0.90
Land Use Fees	2.60	0.99	2.00
Equipment Rental	1.09	1.12	0.26
Hunting Equipment[2]	71.88	51.53	37.91
Licenses	13.20	5.14	7.46
Auxilliary Equipment & Clothing[3]	19.93	5.14	4.81
Taxidermy & Processing	3.00	0.36	0.52

[1] Includes upland game birds.
[2] Guns, bows and arrows, scopes, decoys, game calls, game carriers, ammunition, hand loaders, equipment cases and carriers, dogs and associated costs, other.
[3] Camping equipment, binoculars, snow shoes, skis, hunting clothes, boots, waders, maintenance and repair of equipment, other.

Table 37. Percent Hunter Expenditures by Category (165).

	Hunter Expenditures Big Game	Small Game	Migratory Bird
Fees	8%	5%	9%
Equipment	40%	42%	36%
Transportation	25%	30%	30%
Food & Lodging	27%	22%	25%

In local areas of Montana and for certain types of businesses that rely on travel-induced income, the money spent by hunters may be an important source of income.

Section V. ENVIRONMENTAL CONSEQUENCES, DESCRIPTIONS AND CAUSES BY ALTERNATIVE.

In evaluating the impacts of the alternatives, several environmental parameters were eliminated as being unaffected or not significantly affected by any alternatives. These were:

- Vegetation Quantity and Cover
- Water Quantity and Distribution
- Geology
- Soil Stability and Moisture
- Aesthetics
- Energy Resources
- Historical or Archaeological Sites
- Wilderness Activities
- Social Structures and Mores
- Commercial and Industrial Activity
- Industrial Production
- Employment
- Traffic Flows
- Transportation Networks
- Population Density
- Housing
- Cultural Uniqueness and Diversity

Fourteen environmental parameters were identified as being sensitive to endrin use or to the alternatives. These were:

- Terrestrial Wildlife
- Aquatic and Semiaquatic Wildlife
- Water Quality
- Aquatic Sediments
- Soil Quality
- Air Quality
- Endangered Wildlife
- Recreational Activities and Spending (Community Income)
- Agricultural Production
- Personal Income
- Human Health
- Local and State Taxes or Fees
- Government Services

The positive and negative impacts to these parameters were evaluated for each alternative action. Environmental impacts of endrin restriction were evaluated with the assumption that applications would be done correctly and legally. In instances of incorrect uses additional impacts may occur, and those impacts identified within this EIS may be compounded.

Alternatives 2 through 9 were evaluated by comparing each alternative to Alternative 1 (No Action) (Section III, p. 51). This alternative, even though it was not the desired action, was

determined to be the most realistic baseline to which other alternative actions could be compared. No action, or the status quo, was a situation that was previously determined as needing improvement. It therefore provided a reference point for assessing positive and negative results of alternative actions to restrict endrin use. Following is an explanation of environmental changes that would result from each alternative.

A. No Action (Alternative 1)

Terrestrial Wildlife

This action, maintaining the status quo, would result in a certain amount of environmental contamination. The EPA in its RPAR risk analysis concluded that acute mortality of wildlife such as rabbits was a distinct possibility. This could occur through direct spraying or by consumption of recently sprayed foliage. The endrin residues that will be present on foliage for at least 1 week after treatment may be lethal to some birds and smaller mammals feeding on this foliage. Initial residues present on foliage are within levels that may cause reproductive effects in wildlife. Adverse reproductive effects from endrin are not clearly demonstrated; however, low levels may decrease reproduction through several mechanisms including mutagenic and teratogenic effect in mammals, and decreased egg production and hatchability in birds such as pheasants. Consumption of foliage containing endrin residues may also adversely affect behavior which may reduce survivability. Examples of wildlife that might be affected in Montana include game birds such as pheasants, hungarian partridge, and waterfowl that live in close association with cultivated crops and consume grain plants, songbirds such as horned larks and meadow larks, and mammals such as rodents and jackrabbits. Although acute mortality of larger mammals such as deer and antelope is considered unlikely, chronic effects from dietary residues cannot be discounted.

The possibility for acute secondary poisoning of predators and scavengers appears remote under labeled use of endrin. However, the occurrence of residues in owls and raptors from Montana in 1982 shows that contaminated prey were being consumed, probably frequently. Endrin is rapidly eliminated from birds on an endrin-free diet. Endrin residues in the majority of wildlife analyzed in Montana were at levels not known to be acutely toxic in diets of predators. A special problem is the metabolite, 12 keto-endrin found in rodents, which is extremely toxic to raptors.

The residues in endrin-killed fish would probably not be lethal to scavengers unless kills occurred frequently allowing consumption of numerous fish. Little is known concerning the chronic effects of endrin residues in prey and fish to scavengers.

Low level endrin residues in soils and sediments provide a persistent source of low level contamination for uptake into plants and for accumulation by invertebrates. These residues maybe passed to higher levels in food chains. Some of the residues detected in Montana wildlife in 1981-82 may be the result of endrin being transferred through food chains. The probability of these acquired residues being acutely toxic to vertebrates is remote; but the question of chronic problems cannot be dismissed. The levels found in Montana wildlife are within the limits known to cause behavioral aberrations which may decrease survivability (90, 46).

Aquatic and Semiaquatic Wildlife

The effects on aquatic and semiaquatic animals pose a situation similar to, if not more sensitive than, terrestrial wildlife. The presence of endrin residues exceeding federal action levels in migratory waterfowl created considerable speculation in western states. Because of their migratory nature and the lack of background residue data it is difficult to identify to what extent endrin spraying in Montana contributed to contamination of waterfowl. Because endrin residues were found in terrestrial, nonmigratory wildlife, it is probable that contamination of waterfowl (at some levels) did occur in Montana. Waterfowl, like certain upland game birds present a special problem because of their habits of nesting in and using grain crops for food. Feeding on foliage treated with endrin may result in reproductive and behavioral effects in a small percentage of the waterfowl population. The hazard of acute mortality of waterfowl is probably minimal even though initial residues on wheat foliage are within a lethal range for about 1 week. There is no information to indicate that waterfowl will be acutely poisoned by endrin treatments to small grains.

The fish kill at Sunday Creek illustrates the acute toxicity of endrin and the results of pesticide misapplication. Infrequent reoccurrences of this situation may continue under Alternative 1, particularly on ponds, potholes, and streams on or adjacent to private lands, via drift, runoff of contaminated soil, or misapplication. Other aquatic and semiaquatic vertebrates may be killed as well.

Aquatic invertebrates are important parts of the diets of fish, some waterfowl, shore birds, and other aquatic vertebrates. Certain aquatic invertebrates have been reported to bioaccumulate endrin residues. Under Alternative 1, aquatic invertebrates may be contaminated by endrin residues in sediments and other sources and pass these residues on to higher levels in food chains. Endrin residues in waters adjacent to treated fields will occasionally exceed the criteria recommended by the EPA to protect freshwater aquatic life (0.0000023 ppm as a 24-hour average or 0.00018 ppm at any one time) (170).

Water Quality

Under Alternative 1, endrin will continue to reach streams and ponds, particularly private ponds, by the routes listed above. This will result in transient degradation of the water column for brief periods of time depending upon the water chemistry. Many streams and ponds adjacent to sprayed fields will probably have low level residues for several weeks after spraying and may experience further influxes of endrin adsorbed to soil during periods of runoff.

A primary concern is the potential for contamination of municipal and private drinking water supplies. This possibility is considered remote under current label directions. The recommended ambient water quality criteria for endrin in drinking water is 1.0 ug/l (0.001 ppm) (170). Any endrin contaminated waters should be diluted before reaching municipal withdrawals along the major rivers. Additional residues will be removed by normal filtration of particles to which endrin is adsorbed. There is no information to indicate that endrin has ever been a problem in surface drinking water in Montana, nor is there any evidence that endrin has contaminated ground waters.

Aquatic Sediments

A major portion of any endrin that enters aquatic systems will eventually reside in the sediments. Endrin is relatively insoluble, is rapidly adsorbed to soil particles, and may settle to the sediments. Under Alternative 1 endrin transport to sediments will continue to some degree depending upon several factors such as proximity to treated fields, application methods and conditions, and soil stabilities. Detectable residues can persist for at least 12 months and possibly longer. The significance of these residues is difficult to assess; but they do provide a long term source of low level residues for uptake into food chains.

Soil Quality

Endrin in the soil of treated fields undergoes slow chemical and microbial breakdown and may be detectable for years depending upon environmental conditions. Treated fields in Montana contained residues averaging 0.016 ppm (range N.D. - 0.051) 55 weeks post application. This condition can be expected to occur in varying degrees on fields treated with endrin, although its significance is speculative. Some soil invertebrates can accumulate endrin residues and thereby provide a source of endrin to higher trophic levels.

Vegetation Quality

Under current labeled use, endrin contamination of plants occurs by direct application of the chemical or by absorption of soil residues. Residues on wheat foliage in Montana (1981) averaged

20.85 ppm 2 days post-treatment and dropped to 5.32 ppm in 2 weeks. These residues are within the lethal range to a number of herbivores even though available literature indicates that many mammals may be able to effectively cope with plant residues resulting from direct applications of endrin. In treated grain fields endrin residues will be found in stubble and the regrowth. In Montana, endrin residues were 0.002 ppm in grain regrowth and 0.009 ppm in stubble 55 weeks after application. Samples of grain bin kernels and samples of standing grain kernels collected in 1981 were negative for endrin when analyzed. A similar pattern of persistence can be expected for vegetation other than grain, both within fields and on field borders. The ecological effects of these long term chronic residues are not clear. They do provide a source of endrin in the diets of herbivorous animals.

EPA has not established a tolerance for endrin residues in plant material to be used as livestock forage. As such, plants in fields treated with endrin may be legally unfit for consumption by livestock for at least one year after application.

Air Quality

Endrin can enter the atmosphere through pesticide drift and by volatilization. Up to 15% of the endrin applied by air never reaches the target and may travel considerable distances in the air. Short term high levels of endrin may occur in the immediate vicinity of application sites, but, in general, concentrations of endrin will be within acceptable limits. The endrin label prohibits endrin applications within 1/8 mile of human habitation to reduce the health hazard associated with local air quality problems.

Endangered Wildlife

Five endangered species may be encountered in the vicinity of endrin treatments in Montana - black-footed ferrets, bald eagles, peregrine falcons, whooping cranes, and gray wolves. The existence of the black-footed ferret is very tenuous and any discussion of impacts would be pure speculation. The Environmental Protection Agency, in the Endrin RPAR Decision Document 2/3 stated that the use of endrin in small grains could result in "some risk to bald eagles which may be poisoned by consuming moribund and dead fish".

There is some evidence indicating that declines in raptor populations may be due in part to organochlorine pesticides in their diets. Raptors such as the bald eagle and peregrine falcon are sensitive to endrin. The primary concern for these species is that of secondary poisoning - through the consumption of contaminated living birds for the peregrine falcon and through fish, small mammals and all types of carrion for the bald eagle. Because migration and nesting for both species coincide with cutworm control operations in Montana there is a likelihood for

encountering prey or carrion containing endrin residues. It is unlikely that the residues in wildlife resulting from cutworm control would be acutely toxic to either of these species; however, adverse behavioral and reproductive effects cannot be ruled out with available evidence.

Migrating whooping cranes are known to stop in Montana and feed on invertebrates in a variety of habitats, usually aquatic, but including cultivated fields. The possibility exists, although it is remote, that whooping cranes might stop in small grain fields recently treated with endrin and feed on moribund or dead insects. The potential for acute or chronic effects to these birds is unknown at this time.

Gray wolves are occasional visitors to Great Plains Montana, probably from Canada or the Glacier Park area. The probability for a gray wolf to encounter a small grain field recently treated with endrin is negligible.

Recreational Activities and Spending

There is some evidence that there was a reduction in the number of Montanans choosing to hunt game birds following the detection and publicity about endrin residues in these birds. This logic is undisputable considering the range of opinions among scientific experts concerning the significance of residues to human health and the publicity given to this controversy. The question of human health hazards from endrin residues in game birds, plus the mere presence of these residues, may have reduced the quality of the potential hunting experience for many hunters. In 1981, while license sales increased for most game species, those for birds and waterfowl decreased. Among bird hunters who did purchase licenses in 1981, there was a tendency, on the average, to hunt fewer days as compared to 1980.

Revenues to the Department of Fish, Wildlife and Parks from resident and nonresident bird and waterfowl licenses were significantly less in 1981 compared to 1980 (108). Hunters spent about 243,000 fewer days hunting for the same period (129,500 bird hunter days, 113,500 waterfowl hunter days). It is difficult to estimate what portion of these decreases were caused by endrin contamination of waterfowl. Other factors such as the poor economic situation in 1981 surely influenced the activities of upland bird and waterfowl hunters to some degree.

The reduction in hunter days in 1981 represents a significant change in the amount of money spent by upland bird and waterfowl hunters. Placing a monetary value on this change is difficult because of the range in estimated amount spent in a hunter day (125, 165, 166). In 1981, hunters probably spent from $4 to $8 million less on upland bird and waterfowl hunting. Much of this money was probably spent in another fashion, possibly for other recreational activities, so it does not all represent a loss to the Montana economy but, rather, a change in spending patterns.

Certain businesses that relied on hunter induced revenues may have been impacted.

Agricultural Production

Endrin has been the standard chemical recommended for pale western cutworm control since 1954. It has provided an effective chemical method for reducing the damage of cutworms in small grains under current wheat farming practices. Under the No Action alternative no forseeable changes in grain production would occur.

There is a potential for a small amount of forage production from small grain fields. Growers may graze livestock on these fields before or after grain harvest, and in years where grain yields appear dismal because of low precipitation, growers may harvest grain fields for hay. Both of these practices are prohibited in endrin treated fields and the straw baled from these field should not be used where it can be consumed by livestock. To the farm-ranch operator grazing of grain fields and the potential for forage is an important production consideration which is lost if endrin is used.

Personal Income

Farm income from grain harvest would be unaffected by the No Action alternative. Endrin is priced competitively with currently available chemical alternatives and its proven control provides grain farmers with a consistent and effective method of assuring crop yields despite cutworm infestations.

As previously mentioned, changes in hunting patterns resulting from reluctance of hunters to take contaminated birds may disrupt the economics of those businesses dependent upon travel/recreation expenditures. The extent to which this may have occurred in Montana during 1981 and 1982 has not been determined.

Human Health

The EPA Carcinogen Assessment Group concluded that mutagenic effects of endrin were "equivocally positive". EPA was not willing to review the registration of endrin on the basis of available information concerning mutagenicity. Instead they proposed to resolve the issue through "compliance with Pesticide Registration Guidelines". Because of the statistically significant fetotoxic and teratogenic effects, EPA required that a warning to pregnant women be placed on the label. Even though some carcinogenic tests in laboratory animals were positive the EPA Carcinogen Assessment Group concluded that endrin is "unlikely to be a human carcinogen".

Commercial and a few private pesticide applicators and their employees and families have the greatest risk of exposure to

endrin under currently labeled use. Strict adherence to label directions and precautions will minimize this risk of exposure.

EPA has not set a tolerance level for endrin residues in grain kernels. No tolerances exist for poultry or red meats. A USDA "action level" of 0.3 ppm for poultry and red meat has been in existence for some time as a guideline for making administrative regulatory decisions concerning the level at which these commodities cannot enter interstate commerce.

The disparity between no tolerance for poultry and red meats, and administrative guidelines may reflect the confusion over "safe" levels for human consumption. According to the Environmental Protection Agency there should be little risk of acute or chronic toxic effects to humans under the current label directions and restrictions. However, residues may exceed the 0.3 ppm in a certain number of game animals each year that endrin is used under Alternative 1, the numbers depending upon the extent of spraying. There are no established tolerances for endrin residues in wildlife. However, some health officials have determined that residues at or exceeding 0.3 ppm may present a health hazard to people consuming wildlife over time.

When used according to the label, there is no apparent chance for endrin residues occurring in harvested grain kernels. Available evidence does not suggest any hazard of residues in potable water. There is a possibility for localized air contamination around and downwind of spraying operations. The endrin label prohibits grazing on treated areas or harvest of treated grain for forage. Strict adherence to these restrictions would preclude the possibility of illegal residues in domestic animals or commodities such as milk and eggs.

Local and State Taxes or Fees

The No Action alternative should result in no significant changes in local or state taxes. As mentioned earlier, any reductions in hunting activity have the potential to reduce revenues to the Department of Fish, Wildlife and Parks from license sales.

Government Services

Continued use of endrin may result in a necessity to monitor endrin residues in certain environmental parameters. Such a monitoring project is costly and time consuming. Otherwise, the necessity for government services are expected to be unchanged under the No Action alternative.

B. Endrin Applied by Commercial Applicators Only (Alternative 2)

Commercial applicators undergo more rigorous testing than do farm applicators in qualifying to purchase and apply restricted use pesticides such as endrin. Commercial applicators should thus

have a more thorough knowledge concerning the human health and environmental hazards of such chemicals and should be better equipped to reduce potential hazards caused by misapplication, accidents, improper use, and human exposure.

While Alternative 2 is desirable from the above standpoint, it has little chance for reducing environmental impacts associated with endrin use in Montana. Department of Agriculture records show that about 95% of all endrin applications are now done by commercial applicators. Alternative 2 would not change the use pattern (status quo) significantly. The label violations that resulted in fish kills in 1981 were by commercial applicators.

In comparison with Alternative 1, no positive or negative changes would result in any biological or physical parameters. A slight reduction in the human health hazards of handling and using endrin would occur. The number of applicators handling endrin would be reduced slightly, by restricting applications to commercial applicators. The approximate 100 private applicators that may now apply endrin would no longer be authorized to do so.

C. Buffer Zone Around Private and Public Waters (Alternative 3)

Presently registered endrin labels prohibit application of endrin within 1/4 mile by air and 1/8 mile by ground of ponds, lakes, and streams. However, applications "may be made at distances closer to ponds owned by the user", in other words, ponds on private lands. Alternative 3 would increase these label restrictions by prohibiting endrin use within the same buffer zones around private ponds.

No information exists that would quantify the number of ponds, potholes, lakes, and dugouts on private lands, much less those adjacent to grain fields. However, considering the large number of these bodies of water in Montana, a significant number are probably located on private lands adjacent to grain fields. These ponds provide water, cover and nesting areas for waterfowl, birds, and other wildlife. Many are visited frequently by a variety of game and nongame animals and a few contain private fisheries.

Terrestrial Wildlife

The grassy and brushy cover around private ponds provides cover for a number of species of songbirds, upland game birds, and large and small mammals. Acute mortality, of these and similar species, caused by direct spraying and consumption of recently sprayed insects and plants would be reduced but not eliminated. The most significant benefit would be to small birds and mammals with small home ranges that utilize the cover and unfarmed areas often associated with private ponds.

The benefits of Alternative 3 to upland game birds is questionable. The risk of direct exposure to spray and chronic

residues is reduced by virtue of fewer acres being sprayed. Upland game birds; however, cannot be expected to confine their feeding within a buffer zone. It is doubtful, for example, that the springtime home range of most pheasants and sharptails would fall within a 1/4 mile buffer zone (ground application), much less within the 1/8 mile buffer (aerial application).

The exposure of deer and pronghorn antelope to chronic residues would not be significantly changed. These species would not be expected to have home ranges that fall within the boundaries of a 1/8 to 1/4 mile buffer zone around ponds.

The acute and chronic effects to some terrestrial wildlife as described under Alternative 1 would be reduced but the degree and significance of this is undetermined.

Aquatic and Semiaquatic Wildlife

Ducks and geese both use private farm ponds as brood rearing sites and would derive some benefit from a buffer zone. Even though all nests are not located within 1/8 to 1/4 mile from water, the large majority are. Site selection and nesting occur at about the same time that cutworm outbreaks can be expected to occur. For waterfowl using private ponds as nesting sites, the chances of being directly sprayed would be minimized by a buffer zone.

Depending upon the availability of food and the stage in their life cycle, ducks and geese will travel some distance from water to feed. For example, in the early spring, mallards will fly to grain fields and congregate there to feed. Later, nonbreeders and drakes may continue this behavior to a lesser extent. A buffer zone will not prevent the consumption of grain plants that have been sprayed, particularly during early spring when waterfowl are fairly mobile in feeding behavior. During midsummer, mobility is reduced during brood rearing and molting and feeding is generally confined to waterways and adjacent areas. During this period a buffer zone will result in some benefit, by decreasing the consumption of treated plants around private farm ponds. Alternative 3 should significantly reduce the exposure of waterfowl to endrin residues in their diets during this time period.

A buffer zone should reduce the protracted contamination of water and sediments that occurs during spray drift or the erosion of contaminated soils into private farm ponds. By alleviating this situation, Alternative 3 may reduce the potential contamination of aquatic food chains in and around private ponds.

The effect of Alternative 3 on fish kills would be insignificant. The endrin label now warns that application within 1/8 mile of private ponds may result in fish kills. It should be noted that the fish kills in 1981 occurred due to misapplication.

Water Quality

Alternative 3 would result in no change in the water quality of streams and other bodies of water on public lands. These areas are protected by a buffer zone required by the endrin label. As such, the quality of private and public drinking waters would be maintained.

Ideally, the water quality of farm ponds would be significantly improved by the elimination of direct application and drift, and the reduction of the amount of contaminated soil entering ponds. Although endrin sorbed to soil particles may be transported across the buffer zone by erosion and linger briefly in the water column, under good soil conservation practices the amount would likely be insignificant.

Aquatic Sediments

No change can be anticipated in streams and other waters not on private lands. Reduction of the amount of endrin potentially entering private ponds, as mentioned above, will directly reduce residues in the sediments.

Soil Quality and Vegetation Quality

The range of values for endrin residues in soils and vegetation, and the persistence of endrin in treated fields would remain the same as under Alternative 1. A buffer zone around private ponds would have the net result of fewer acres being treated with endrin, hence a small reduction in contaminated acreage.

Air Quality

Air quality would remain the same as that described under Alternative 1.

Endangered Wildlife

The result of fewer acres around ponds being treated with endrin might reduce the potential hazard to bald eagles, peregrine falcons, and whooping cranes. However, any benefit would be slight because of their mobility which would enable these birds to encounter treated areas.

Recreational Activities and Spending

The key issue in this environmental parameter is the potential for endrin residues in game birds and the resulting effects on the activities of upland bird and waterfowl hunters. There is no evidence to indicate that buffer zones will greatly affect the residues in upland game birds. In waterfowl, the number of contaminated birds could decrease, but a few could still carry endrin residues greater than 0.3 ppm. Given these probabilities it would appear that cautionary statements and instructions on

cleaning and cooking birds should be continued; and that periodic reductions in bird hunter license sales and activities would continue.

Agricultural Production

Alternative 3 should not cause significant changes in agricultural production providing that alternatives for controlling cutworms remain available. It should be noted that, although alternative chemicals are available for 1983, none have yet been granted permanent registrations. Should these alternatives, for any reason, become unavailable to growers, Alternative 3 could result in significant impacts to small grain production.

Presently these two alternative chemicals, chlorpyrifos and permethrin, are available and can be used to treat entire fields or just a buffer zone around ponds. The chlorpyrifos label does not specify a buffer zone but cautions against contaminating waters. Permethrin spraying is prohibited within 200 feet of water by air application or within 50 feet by ground. Use of permethrin could result in an untreated buffer. For example, for a 2 1/2 acre pond surrounded by grain, 1.5 or 8.2 acres would be untreated, depending upon the buffer zone size. Lost grain production could amount to about 22.5 to 123 bushels (60% loss of potential yield of 25 bu/ac).

Personal Income

Alternative 3 would force growers to use alternative chemicals or methods to treat cutworm infestations around private ponds. Under present market conditions this should cause experience no reduction in personal income. Table 38 gives an example of wheat production and income for a 1/4 mile buffer treated with alternative chemicals for cutworm control.

Under Alternative 3 reduction of bird hunter activities could continue. As a result, disruptions in the income of businesses that rely on travel/recreation expenditures could occur. The extent of this is undeterminable.

Human Health

Alternative 3 would probably reduce the number of waterfowl carrying endrin residues over 0.3 ppm, and thus would have a slight overall benefit to the possible health risks associated with consuming contaminated waterfowl. No such decrease in contamination could be expected for upland game birds or other wildlife. The hazards of applicators and handlers being exposed to endrin during spraying operations would be the same as under Alternative 1. As such the benefits of Alternative 3 to human health are considered insignificant.

Table 38. Projected Winter Wheat Yields and Income From a 1/4 Mile Buffer Surrounding a 2 1/2 Acre Private Pond.

	Alternative 1	Alternative 3	
	Endrin	Permethrin	Chlorpyrifos
Treated Acreage[1]	161	152.8	161
Untreated Acreage	0	8.2	0
Yield[2]	4,025	3,902	4,025
Chemical Cost[3]	$1,055-1,319	$764	$831-1,665
Gross Income[4]	15,657	15,179	15,657
Gross Income Less Chemical Cost	14,338-14,602	14,415	13,992-14,826

[1] 161 is the number of acres in a 1/4 mile buffer zone around a 2-1/2 acre pond.
[2] Based on average yield of 25 bushels/acre and 60% loss on untreated acreages.
[3] Does not include application costs.
[4] Based on 1981 average selling price for winter wheat of $3.89/bushel.

Local and State Taxes or Fees

Continued reductions in the purchase of hunting licenses by waterfowl and bird hunters could occur, although to a lesser extent than under Alternative 1. The reduction in license sales represents a potential loss in fees to the Department of Fish, Wildlife and Parks.

Government Services

Registered endrin labels already prohibit endrin applications around ponds on public lands and around any streams or lakes. The addition of private ponds would not result in any significant requirements for additional government services other than monitoring compliance. This compliance would require additional field and laboratory manpower, and increased operational expenses (supplies and travel).

Monitoring for endrin residues in game animals would probably be necessary.

D. Require Commercial or Private Applicators to Complete Training by the Department of Agriculture Prior to Endrin Purchase (Alternative 4)

Presently, applicators must be certified in order to purchase restricted use pesticides such as endrin. Alternative 4 would require additional special training to purchase and use endrin.

Training would cover cutworm control and endrin use. An example of a similar situation is the special training that is now required by applicators of aquatic herbicides. This training was instituted to help reduce the potential for fish kills from the release of aquatic herbicides into public waters. To this point the training program appears to have accomplished that goal.

Terrestrial Wildlife

The possible hazards of endrin to terrestrial wildlife would not likely be significantly reduced by special training. The contamination of wildlife occurs when endrin is used according to the label and is due more to the close association of wildlife with grain fields than to the incorrect use of endrin. For example, upland game birds, waterfowl, songbirds and small mammals utilize grain fields and surrounding areas for food and cover and are thus inherently exposed to grain farming practices such as the use of endrin. Deer and pronghorn consume browse and forb species in grain fields and are thus exposed to endrin residues.

Special training would educate applicators on the toxicity of endrin to wildlife and on the behavior of endrin residues. A Department survey (103) has shown that the majority of growers are concerned with the welfare of wildlife and will do what they can to protect wildlife while farming or ranching. Thus, in the case of private applicators, training would probably influence some growers to choose less hazardous alternatives for cutworm control.

Aquatic and Semiaquatic Wildlife

Fish kills that occurred in 1981 were due to incorrect application of endrin. This problem might be reduced by special training with the expected result being more careful application of endrin according to label directions.

The problem of residues in the diets of waterfowl would not be corrected by special training. Geese and ducks utilize grain fields for nesting and food and would occasionally be exposed to potentially hazardous endrin residues on treated foliage.

The same potential would exist for endrin residues being transported to private and public waters, with the resulting contamination of sediments and aquatic food chains.

Water Quality

Some positive benefits to the quality of streams, lakes, and ponds on public lands would probably result from special training. Experiences with aquatic herbicide applicators demonstrate that special training has a positive benefit on the correct application of chemicals. Correct application of endrin involves a buffer zone around all streams, and ponds on public

lands. Adherence to this restriction should preclude the brief degradation of water quality that can result when endrin enters waterways.

The endrin label does not stipulate a buffer zone around private ponds. These ponds would be subject to brief degradation of water quality following endrin applications and during runoff of contaminated soils. Public waters would also receive small amounts of endrin contaminated soils during periods of runoff, although this probably would not result in a significant reduction of water quality.

Aquatic Sediments

Endrin transport to the sediments of private ponds will continue via drift and runoff from treated fields. Transport to streams, and ponds on public lands, will continue to a lesser degree but should be reduced somewhat by special training. Even so, the potential for long term residues in aquatic sediments would continue with residues in the general area of endrin use being detected for greater than one year in some sediments.

Soil Quality and Vegetation Quality

The range of values for endrin residues in soils and vegetation, and the longevity of endrin in treated areas would remain similar to those measured during 1981 monitoring. Average endrin residues in soil were 0.016 ppm (range N.D. - 0.051) 55 weeks after application. Residues in wheat foliage which were initially over 20 ppm, declined to about 5 ppm in two weeks, and were still present at about 0.01 ppm 55 weeks after application. The initial residues were within a range hazardous to herbivorous animals. Long term residues provide a source of contamination for wildlife and other animals consuming vegetation in and around treated fields. Alternative 4 would not change the quality of soil and vegetation in treated areas in comparison with Alternative 1.

Air Quality

Local temporary degradation of air quality would continue at the application site although, in general, concentrations of endrin in the air will be within acceptable limits.

Endangered Wildlife

If the contamination of public waters with endrin and resultant fish kills are reduced by special training then the hazard to bald eagles from consuming moribund and dead fish should be reduced. The bald eagle, peregrine falcon, gray wolf, and whooping crane would derive no other benefit under Alternative 4 due to their mobility and ability to encounter treated areas.

Recreational Activities and Spending

The same potential for reducing waterfowl and bird hunter activities exists under Alternative 4 as under No Action (Alternative 1). There is no reason to conclude that special training would significantly reduce endrin residues in waterfowl and upland game birds. Faced with the uncertainty of these residues a number of hunters may decide against bird hunting.

Agricultural Production and Personal Income

No change in small grains production and personal income to small grain growers could be expected under Alternative 4.

There is some question concerning reductions in the income of local travel dependent industries that may be affected by a decrease in waterfowl and upland bird expenditures.

Human Health

The potential hazards of endrin to human health, its acute toxicity, teratogenic and fetotoxic characteristics and endrin residues in game animals would remain relatively unchanged by Alternative 4, or the same as the No Action Alternative.

Special training on the human health hazards of endrin should result in more careful use of endrin according to label directions by pesticide applicators. As such, the hazards to applicators and handlers would be reduced.

Local and State Taxes or Fees

Any reduction in bird hunting activity would result in fewer license sales which represents a potential revenue loss to the Department of Fish, Wildlife and Parks.

Government Services

Training would be required by commercial applicators and a limited number of private applicators. Realistically, 4 to 6 training sessions would be required the first year that Alternative 4 is implemented followed by 2 per year for successive years. A considerable commitment of staff time and travel expenses would be required.

Monitoring for endrin residues in game animals would probably be necessary.

E. Endrin Applications Restricted to Ground Equipment Only (Alternative 5)

Presently, endrin can be applied by ground rig or by aircraft; however, the majority of applications are done by air. Alternative 5 is attractive because the potential for off-target

drift of pesticides is much less by ground application than by air. Thus, a significant source of endrin to off-target areas such bodies of water and noncrop areas might be reduced.

Terrestrial Wildlife

Terrestrial wildlife would derive some benefit from the prohibition of aerial applications of endrin. The hazard of acute mortality resulting from direct application would be reduced by the ability of some wildlife such as birds and larger mammals to avoid ground application equipment. Small mammals and other less mobile wildlife could be acutely poisoned due to direct application.

Residues on foliage in treated areas would not be reduced by Alternative 5, and may be greater than the residues expected under Alternative 1. Ground application usually results in more chemical reaching the target by virtue of less drift. Herbivores would be exposed to the same or greater hazards of acute mortality or chronic effects resulting from consumption of contaminated grain foliage. The transfer of endrin residues to higher trophic levels (predators) would not be reduced. Alternative 5 would have little or no overall benefit to terrestrial wildlife in comparison to present conditions.

Aquatic and Semiaquatic Wildlife

In Great Plains Montana, drift is a source for contamination of aquatic areas and inhabitants. The buffer zone around streams, and other waters on public lands, is now 1/8 mile for ground applications and 1/4 mile by aerial applications. The restrictions reduce the potential for accidental application or drift of spray into waters. Restricting applications to ground rig might slightly improve the protection of aquatic areas. However, fish kills could still result from correct use of endrin or from misapplications, as could contaminatation of aquatic ecosystems.

Alternative 5 may increase the possibility of endrin entering waters via erosion (wind or water) of endrin contaminated sediments across the 1/8 mile buffer (ponds and lakes on public land and streams). Under present conditions (Alternative 1) most applications are done aerially which requires a 1/4 mile buffer zone. In areas of higher precipitation, runoff containing endrin residues has been implicated in fish kills. In Montana, the chances for fish kills resulting from runoff of contaminated soils would be remote. However, endrin residues may be transferred across the buffer zone by runoff or wind erosion, and provide a chronic source of contamination to aquatic and semiaquatic wildlife. Again, the buffer zone is not specified for ponds on private lands (or is left to the owner's discretion). Erosional transport of endrin into these ponds would continue with resultant contamination of aquatic food chains.

No significant change in the contamination of ducks and geese with endrin could be expected.

Water Quality

The net effect of Alternative 5 would be to improve water quality by reducing transient degradation by drift from aerially applied endrin. This would seem to be the most significant source in a semiarid region such as Great Plains Montana.

Reduction of the buffer zone to 1/8 mile would probably result in short term contamination of waters with endrin during periods of runoff or during other erosional processes. The possibility for this occurrence would be greater than that under present conditions although the significance would be negligible. Endrin levels in public and private drinking water would remain within proposed critera.

Aquatic Sediments

The possibility for contamination of aquatic sediments with endrin would probably not be significantly changed by Alternative 5 compared to present conditions. The use of ground equipment would decrease the hazards of drift to waters, and the resultant contamination of sediments. However, the buffer zone would be reduced to 1/8 mile around lakes and ponds on public lands and all streams (compared to the 1/4 mile buffer now required for aerial applications). This could increase transport of endrin contaminated soils into waters, although the significance of this in a semiarid region such as the Great Plains is probably minimal. Some recurrences of sediment contamination similar to that reported from the 1981 monitoring program may continue, especially around private farm ponds where no buffer zone is specified on the endrin label.

Soil Quality

No improvement in soil quality would result from Alternative 5. Endrin residues in treated soils would be at the same levels, if not slightly greater, than those resulting from Alternative 1, No Action.

Vegetation Quality

The levels of endrin residues in vegetation, would not be improved in treated areas compared with present conditions. If anything, slightly more endrin would reach the vegetation on treated areas due to the mechanics of ground sprayers, resulting in higher initial residues.

Drift of chemical to nontreated areas would be reduced by using ground sprayers. The result might be an improvement in the quality of vegetation adjacent to treated fields.

Air Quality

As under Alternative 1, temporary high levels of endrin may occur in the air in the immediate vicinity of treatment sites. However, with ground rigs the potential for downwind drift is much lower than for aircraft (2). The net result of Alternative 5 would be fewer spray particles transported downwind away from the treatment area.

Endangered Wildlife

No benefits or reduction in potential risks to bald eagles, whooping cranes and peregrine falcons could be expected under Alternative 5.

Recreational Activities and Spending

The changes in bird hunting activity that occurred in 1981 were a result of residues in game birds, controversy over the potential for health problems caused by consuming contaminated birds, and warnings issued to hunters concerning the care and consumption of game birds. Under Alternative 5, residues in waterfowl and upland birds would probably not decrease significantly. For this reason the potential would still exist for reduced recreational opportunities and the resultant decrease in related expenditures caused by hunters' reluctance to hunt contaminated birds.

Agricultural Production

Technically, agricultural production could be maintained under Alternative 5. Ground application of endrin can be as effective as aerial application in controlling losses in production caused by cutworms.

Realistically, Alternative 5 would probably result in the application of alternative chemicals that could be applied aerially for cutworm control. Insecticide applications are usually done by commercial aerial applicators, and most would probably continue to be done in this manner.

Personal Income

Grain growers choosing to personally apply endrin using ground rigs would not incur any significant changes in personal income. Endrin application by commercial applicators using ground rigs would be more expensive than current aerial application costs. Under Alternative 5, if growers chose to use alternatives to endrin, then no significant impacts to personal income could be expected assuming that alternatives continue to be available, are as effective, and are about the same price as endrin.

Reductions in upland bird and waterfowl hunter activities might continue. As a result, disruptions in the incomes of businesses that relied on hunter expenditures could occur.

Human Health

Incidental human exposure to endrin, via drift, would be reduced but this is hardly of any consequence considering the possibility for the increase in the number of farm applicators exposed to endrin during handling and applying endrin. Alternative 5 could induce a greater number of farm applicators to personnaly apply endrin using their own ground sprayers. EPA's RPAR Decision Document 2/3 stated that "the populations with the greatest potential dermal exposures to endrin consist of persons who are directly involved in the ground application of endrin, and persons who are involved in the mixing, loading and transfer operations related to both aerial and ground application".

The possible hazards associated with the consumption of wildlife containing endrin residues would probably be the same as under Alternative 1.

Local and State Taxes and Fees

Fees from bird licenses and duck stamp sales might be reduced under Alternative 5.

Government Services

No change in government services could be expected except for the possibility that monitoring for endrin residues in game animals would be necessary.

F. Use of Endrin Only Where Economic Infestations Are Confirmed by Trained Individuals to Exceed 1% of a County's Total Planted Small Grains Acreage in a Given Year (Alternative 6)

The intent of Alternative 6 is to reduce the yearly acreage treated with endrin by allowing its use only during cutworm outbreaks (defined as infestations greater than 1% of the small grains acreage in a given year).

To adequately analyze the environmental impacts caused by Alternative 6 requires knowledge of the frequency at which cutworm outbreaks exceed 1% of a county's small grains acreage. Unfortunately, most of the available information deals only with outbreak situations, local or statewide, and cases where infestations reached economically damaging levels. This information shows that economic infestations of cutworms have occurred over 75% of the years since 1953. The infested acreages have varied widely from year to year.

Under Alternative 6 endrin use would have been reduced in 1982. In Cascade County where about 2,000 acres were treated with endrin, less than 1% of the county's acreage was infested. Likewise, a total of 1,170 acres were treated with endrin in Lewis and Clark, Judith Basin, and Teton Counties, none of which had infestations equalling or greater than 1% of the small grains

acreage. Golden Valley County, on the other hand, had a serious cutworm problem in 1982 that far exceeded 1% of the planted grain acreage.

Under Alternative 6, the small scale spraying of endrin such as occurred in 1982 in Lewis and Clark, Judith Basin, and Teton Counties would not be authorized. There is no doubt that this type of endrin use results in a chronic, local type of environmental contamination, however the significance of this contamination is questionable compared to the large scale spraying during outbreaks such as that in 1981. It would seem that large scale endrin use would result in more serious and widespread environmental problems than the small scale use such as that in 1982.

Terrestrial Wildlife

The net result of fewer acres being treated with endrin would seemingly have an overall positive benefit to terrestrial wildlife. Benefits would most likely occur in years when cutworm infestations were low, or in areas with small infested acreages. The significance of these benefits is questionable; it is doubtful that they could be measured except on a very localized basis.

During years when widespread cutworm outbreaks occur, the effects of endrin to terrestrial wildlife would probably be cumulatively similar to the present conditions (Alternative 1). Treated acreage might be slightly reduced by the restrictions of Alternative 6; however, this reduction would probably not be significant in counties with widespread infestations.

Aquatic and Semiaquatic Wildlife

The same logic as outlined above would apply to waterfowl, which may obtain endrin residues in much the same way as terrestrial wildlife, i.e. by feeding in treated fields. During outbreak situations the potential for fish kills and the potential for contamination of aquatic food chains would remain much the same as under Alternative 1. During non outbreak years Alternative 6 would result in some benefit in localized situations as the result of fewer acres being treated with endrin.

Water Quality and Aquatic Sediments

The incidence of input of endrin into bodies of water and subsequent transfer to sediments would logically be reduced; however, the significance of any benefit is undeterminable. In cases where endrin was authorized and during outbreak years, the potential for contamination of water and sediments would be the same as under Alternative 1, as would be the range and longevity of residues in these aquatic parameters.

Soil Quality and Vegetation Quality

The range of values for endrin residues in soils and vegetation, and the longevity of endrin in treated areas would be the same as under Alternative 1 even though the amount of soil and acres of vegetation that would be contaminated would likely be reduced, especially in years where cutworm populations were low.

Air Quality

Fewer cases of local degradation of air quality in the immediate vicinity of treatment sites would occur. In general, concentrations of endrin in the air away from treatment sites would be within acceptable limits.

Endangered Wildlife

During years when cutworm outbreaks are widespread as in 1981, the risks to some endangered wildlife would be the same as those described for Alternative 1. Where endrin use was not authorized some benefit would accrue to endangered wildlife.

Recreational Activities and Spending

Alternative 6 would result in an average reduction in the number of acres that could potentially be treated yearly with endrin. The percentage of game birds and other wildlife with residues exceeding 0.3 ppm would probably be reduced. However, even during years of local, small scale spraying such as that occurring during 1982, contaminated waterfowl were present on a localized basis. This type of local contamination probably has the potential for reducing hunting activities and spending in those counties where spraying was authorized. During years of widespread cutworm outbreaks treated with endrin, impacts on hunting activities and spending would be similar to Alternative 1.

Agricultural Production

In situations where cutworm control is necessary but the infested acreage is less than 1% of a county's total acreage, growers should have alternative chemicals to use. These alternatives have, thus far, been shown to be as effective as endrin in controlling cutworms; however, the alternatives are not permanently registered and their availability is not guaranteed. If the alternatives become unavailable, this could result in adverse economic impacts on grain production.

Personal Income

At this time the alternative (Section 18, FIFRA, as amended) chemicals are not significantly different from endrin in cost or efficacy. No reduction in personal income could be expected

under Alternative 6, as long as effective alternative controls are available.

Continued reductions in hunter activities might disrupt the incomes of busniesses relying on hunting expenditures.

Human Health

When cutworm problems are small and endrin use is not authorized there should be some mitigation of potential human health risks related to residues in wildlife and exposure during applications. In each county in which endrin was authorized, the same potential human health hazards outlined under Alternative 1 would be present.

Local and State Taxes or Fees

Fees realized from duck stamp and bird license sales might be reduced under Alternative 6.

Government Services

Alternative 6 would require a government program to provide yearly monitoring of cutworm outbreaks in all counties in Montana. This would result in a significant increase in the need for government services.

The Montana Department of Agriculture would be responsible by law for coordinating such a monitoring system, training qualified persons for monitoring cutworms in each county, maintaining records, and generally enforcing the program. From March through May each year an additional employee would be required to coordinate this program and provide the necessary training.

At the county level, a program to monitor acreages infested with cutworms would probably be best handled through the Cooperative Extension Service. County agents are commonly the first government officials informed of local cutworm problems. Communication between growers and extension agents is, in most cases, already established. To carry out Alternative 6 at the county level would require a trained temporary employee working in cooperation with the extension agent to inspect fields, determine whether infestations were economic, and to maintain records. State funding would be required to fund these approximately 20 to 25 temporary positions.

Further monitoring for endrin residues in game animals might be necessary.

G. Endrin Application Only After Confirmation of an Economic Infestation by Trained Individuals on a Field by Field Basis (Alternative 7)

The intent of Alternative 7 is to reduce the yearly total amount of endrin spraying by restricting applications to those fields that have been surveyed and found to be economically infested with cutworms. Ideally, this type of decision-making process should already be used; however, the identification of cutworm species and the determination that economic levels are present requires a working knowledge of insect taxonomy, ecology, and pest management principles. Because of the difficulty of this it is possible that a number of fields are sometimes treated improperly or when economic levels of cutworms are not present.

The basic principle of this system is drawn from among the concepts of integrated pest management (IPM), that of treating only those fields where pests reach an economic threshold or population level at which the cost of damage justifies the cost of treatment. This type of system benefits growers by minimizing unneeded treatments, and assuring correct timing for needed applications.

Terrestrial Wildlife

There is no guarantee that a prudent monitoring program, which would be necessary to confirm economic infestations, would reduce the treated acreage or the potential impacts of endrin spraying to terrestrial wildlife. Even though the number of acres treated by endrin could possibly be reduced, the benefits of this are speculative. Because there is no certainty that the treated acreage would be reduced, impacts would be about the same as those described under Alternative 1 (No Action).

Aquatic and Semiaquatic Wildlife

Alternative 7 would probably not result in a significant decrease in the number of fields sprayed over several years. The impacts to fish, waterfowl, aquatic invertebrates and other aquatic wildlife would remain nearly the same as those discussed under Alternative 1.

Water Quality and Aquatic Sediments

Alternative 7 would not significantly reduce the possibility of water and sediments being contaminated. There is no evidence that the statewide reduction in treated fields would be significant. Bodies of water and aquatic sediments could receive endrin contamination as described under Alternative 1.

Soil Quality

In those fields treated with endrin, residues would be similar to those encountered during the 1981 monitoring program in which

residues in soil averaged 0.016 ppm 55 weeks after treatment with endrin. No significant decrease in the number of treated fields could be expected over time.

Vegetation Quality

In those fields treated with endrin, initial residues on vegetation within the field and on border areas are within the ranges of being acutely hazardous to herbivorous animals. Long term residues may cause chronic health effcts to wildlife. Residues will be measurable in regrowth and stubble for at least 55 weeks after application making treated fields unfit for grazing livestock for over 1 year.

Air Quality

During endrin applications high endrin levels in the air would result for a brief period in the immediate vicinity of application sites. Where label precautions are followed, the potential hazards to human health should be mitigated.

Endangered Wildlife

The potential for hazards to endangered species would probably not be significantly mitigated by Alternative 7. Some risk to bald eagles from consuming moribund and dead fish would be present. The hazards to endangered wildlife would be about the same as described under Alternative 1.

Recreational Activities and Spending

Endrin residues in upland game birds and waterfowl would not be significantly reduced by Alternative 7. Periodic declines in the number of hunters choosing to hunt birds, similar to that which occurred in 1981, could be expected to continue.

Agricultural Production

Technically, if economic infestations could be confirmed on a field by field basis in a timely manner, some benefits in grain production would occur. The result of control efforts being conducted at the correct time and only when warranted should result in more efficient cutworm control and economical farming practices. While this may ideally be the case, it may not be realistic because of the logistics of such a program and the amount of government services required (see Government Services).

Personal Income

If the program proposed by Alternative 7 was organized so that infested grain fields could be inspected on a timely basis, then personal income of at least some grain farmers would be improved. Authorizing and timing endrin applications when cutworm infestations economically merited treatment would result in more

efficient pest management in those cases where growers had not been following such a program.

In some cases no benefits in personal income would be recognized to wheat growers. This would be the case where an effective program of pest identification and correct decisions on control efforts had been was utilized by growers as a normal operational practice.

Under Alternative 7 there is a possibility for occasional impacts to the income of industries dependent upon travel induced income. These impacts are contingent upon waterfowl and bird hunting opportunities being affected by endrin residues in these game birds.

Human Health

Alternative 7 would not significantly mitigate potential health risks. There is no evidence that the number of contaminated game animals would decline, nor would residue levels in these animals. The potential health hazards that are inherently associated with the handling and use of endrin would not change significantly.

Local and State Taxes or Fees

Under Alternative 7, periodic declines in the number of waterfowl and upland game bird hunters may continue. A resultant decrease in fees derived from license sales could result.

Government Services

A considerable seasonal staff of trained surveyors would be necessary to insure that fields could be surveyed on a timely basis. In 1981, approximately 35 trained surveyors strategically located in Montana would have required about 69 man-weeks to survey the 98,500 acres commercially treated with endrin. The actual number of acres requiring a survey would have been greater. Similar commitment in the future would have a yearly cost of approximately $15,000.00 for salaries, $2,200 for benefits and $8,000 for travel expenses. Other expenses for surveying would include funds for communications, equipment, supplies and office space.

A considerable effort would be required from present Department staff to hire and train personnel, keep records, and coordinate the survey.

Further monitoring for endrin residues in game animals might be necessary.

H. Limit Endrin Sales in Montana to 5,000 Gallons Per Year (Alternative 8)

Alternative 8 would permit limited use of endrin to control the annual problems with cutworms in Montana and would limit treated acreage to 32,000 - 40,000 acres yearly. By limiting sales to 5,000 gallons, the treated acreage would not exceed the "normal" infested acreage which amounts to about 40,000 acres yearly. The large scale treatments with endrin such as that which occurred in 1981 (when about 15,400 gallons were sold) would be curtailed. In years such as 1982 when total endrin sales were less than 5,000 gallons no restrictions on sales would be imposed.

Years when cutworm infestations exceed the "norm" of 40,000 acres probably occurs about 1 year out of 4, although the frequency appears to have increased in recent years. During the intervening years infestation levels are usually less than 40,000 acres.

Terrestrial Wildlife

During serious outbreak years as many as 250,000 acres of wheat can require treatment for cutworms. During these and less serious outbreaks reducing the number of acres treated with endrin to 40,000 or less would result in a substantial overall benefit to terrestrial wildlife.

A quantitative evaluation of the benefits to terrestrial wildlife resulting from Alternative 8 is difficult. On fields that are not treated with endrin, wildlife will not be exposed to the potential hazards of acute mortality resulting from being directly sprayed or consumption of treated foliage. Chronic effects related to the consumption of contaminated foliage or prey could be reduced.

In those fields that are treated with endrin, terrestrial wildlife will be exposed to those hazards described under Alternative 1 (No Action).

Aquatic and Semiaquatic Wildlife

During many outbreak years the exposure of aquatic wildlife to endrin will be reduced by virtue of fewer acres being treated. The possibility for fish kills should be reduced in those years as should the potential for drift or runoff of endrin into aquatic systems and the subsequent transfer of endrin through food chains.

In localized areas where endrin is used, some contamination of aquatic organisms may occur whenever endrin enters waterways, accidentally or through erosional processes. In these cases the possibility for occasional fish kills would be present, as would the potential for contamination of aquatic invertebrates and

other organisms near the bottom of food chains and the subsequent passage of these residues to higher trophic levels.

The exposure of geese and ducks to endrin residues in crops and in aquatic foods and the occurrence of residues in waterfowl should be reduced during outbreak years. However, monitoring of endrin residues in waterfowl in Montana has indicated that local spraying can result in high residues in nearby waterfowl populations. In 1982, endrin residues exceeding 0.3 ppm were detected in waterfowl collected in counties where less than 1% of the small grain acreage was treated with endrin. The number of contaminated waterfowl should be less when endrin use is limited to no more than 5,000 gallons.

Water Quality

The possibility for endrin residues entering waterways via drift or erosional processes would be reduced during those years that endrin use is limited.

In those areas where endrin use occurs, the possibility will exist for contamination of public and private waters. Adherence, by applicators, to buffer zones should preclude drift into streams and public waters in most cases but may result in low level contamination through erosional processes which carry endrin residues across the buffer zone. Contamination of private ponds could continue to occur at the owner's discretion.

Endrin in surface or ground waters used for human consumption should not exceed proposed ambient water quality criteria.

Aquatic Sediments

The possibility for endrin to enter aquatic sediments should be reduced during outbreak years when endrin use is curtailed at 5,000 gallons. However, there would be a potential for transport of endrin to aquatic sediments near treated areas. Where this occurred, residues would likely persist for at least 12 months depending upon characteristics of the water and the nature of the sediments.

Soil Quality and Vegetation Quality

During cutworm outbreaks the curtailment of endrin use at 5,000 gallons would result in a reduction of treated acreage depending upon the severity of the outbreak. In and around those fields that were treated, soils and vegetation would contain endrin residues similar to those measured in the 1981 monitoring program.

Air Quality

During cutworm outbreaks, a number of potential cases where air could be locally and briefly contaminated with endrin would be curtailed. In those areas where endrin was used, temporary high endrin levels in the air in the immediate vicinity of application sites would result.

Endangered Wildlife

In years where endrin use was curtailed at 5,000 gallons and the remaining infested grain fields were treated with alternative chemicals, endangered species would benefit from some reduction in the potential risks associated with endrin residues. Ascribing any degree of significance to this reduction is difficult. Even during years when treated acreages are kept at 40,000 acres or less, potential hazards to endangered species may exist in the form of moribund and dead fish and other contaminated carrion for the bald eagle, contaminated birds for migrating peregrine falcons, and contaminated invertebrates for whooping cranes. Neither the bald eagle or the peregrine falcon are likely to encounter carrion or prey containing acutely toxic residues; although chronic problems including behavioral changes and reproductive effects cannot be discounted.

Recreational Activities and Spending

Initial results from wildlife monitoring conducted in 1982 by the Department of Fish Wildlife and Parks suggested that even during years when endrin use is low, endrin residues can be detected in waterfowl and game birds. In areas of endrin use in 1982, the incidence and degree of endrin residues in waterfowl appeared to be similar to those measured in 1981 even though the contamination of waterfowl did not appear to be as severe or widespread as in 1981 when endrin use was far more extensive. It appears that the potential for reductions in hunting activities would exist even during years of minimal endrin use. Much of the change in hunting probably depends upon how much significance is placed on residues by health authorities, and on whether hunters feel that contaminated birds are localized or statewide.

Agricultural Production

No changes in agricultural production could be anticipated under Alternative 8. Chemical alternatives to endrin were made available for controlling cutworms from 1981 to 1983. However, full registration is still pending with EPA. If, for some reason, chemical alternatives were not available, serious impacts to agricultural production could result under Alternative 8.

Personal Income

Personal income of grain growers would probably not be changed by Alternative 8. Chemical alternatives are comparable in price to

endrin, and appear to be effective in controlling cutworms. If, for any reason, alternatives were not available or were not efficacious in Montana, personal income would be adversely impacted.

Human Health

Even though endrin use would be curtailed during certain years resulting in an overall decrease in the amount of endrin applied in Montana, it is difficult to say that potential adverse human health effects would be significantly mitigated. Overall, the number of applicators and handlers exposed to endrin would be reduced. The potential problems with endrin residues in wildlife and the teratogenic effects of endrin would continue to be of concern to health experts.

Local and State Taxes or Fees

Periodic declines in the number of waterfowl and upland game bird hunters may continue although this could be on a more localized basis than the general reduction that occurred in 1981. Any such declines may result in lost revenues from hunting license sales.

Government Services

Alternative 8 would require a system to monitor endrin sales and to maintain records. Sales and distribution of endrin would probably best be handled at the manufacturer-distributor level. Cooperation of endrin manufacturers would be required (regulated) to assure that no more than 5,000 gallons of endrin were distributed to dealers annually in Montana.

Dealers are now required to submit monthly reports of restricted pesticide sales in Montana. These reports would provide an after-the-fact record of endrin sales.

An estimated 2 work weeks would be required yearly to effectively monitor endrin sales under Alternative 8. Enforcement activities would require additional time.

Additional monitoring for endrin residues in wildlife would probably be necessary.

I. Suspend Sales and Use of Endrin - Cancel Endrin Registrations When Alternatives Are Registered by the Environmental Protection Agency (Alternative 9) Proposed Action

The Montana Pesticides Act, Section 80-8-105 (2) (a) permits the Department of Agriculture to prohibit the use of pesticides where necessary to protect persons, animals, or other aspects of the environment. Alternative 9 would suspend sales and use of endrin on small grains and the endrin registration would be cancelled

when effective chemical alternatives are registered by the Environmental Protection Agency and the State of Montana.

Endrin has provided grain growers with an effective chemical to control cutworms, particularly the pale western cutworm, when no other effective alternatives were available. For this reason grain growers have relied on endrin to control these pests that can be economically devastating to small grain crops.

Suspending the use of endrin presents several potential problems. First, the effective alternative chemicals, chlorpyrifos, permethrin, and possibly others have not yet been federally registered for use on small grains. For several years these chemicals have been made available to growers by a special process that permits pesticides to be used in emergency situations. These pesticides are exempted from the complete review and testing that must be accomplished prior to federal registration. Complete federal registration is desirable because of the rigorous environmental and health testing that is required.

A second consideration is that grain growers must have effective alternative methods that will work in the grain growing environs of Montana to control cutworms. Preliminary information indicates that alternatives will be effective but there are questions to be answered by State entomologists. Most of the questions center around the degree of effectiveness of the alternatives under differing sets of climatic conditions, especially in comparison with a proven reliable compound such as endrin.

Finally, it would be a mistake to consider alternative chemicals as environmental panaceas. While those now available do not have the persistent chemical property of endrin, they do present certain health and environmental problems. These will be discussed, in a general context under the appropriate environmental headings.

Terrestrial Wildlife

Alternative 9 would mitigate the potential for acute and chronic effects to terrestrial wildlife that may result from endrin use.

Neither of the available alternatives are generally as acutely toxic to terrestrial wildlife as endrin, although chlorpyrifos is moderately to severely toxic to birds. Table 39 illustrates the relative toxicities of endrin, chlorpyrifos, and permethrin. There is very little chance that acute mortality of terrestrial mammals caused by direct spraying would result from the use of chlorpyrifos or permethrin. Permethrin generally poses no acute toxicity hazard to birds. Chlorpyrifos has not generally resulted in mortality of birds except in one instance where deaths of mallard ducks were attributed to the consumption of moribund and dead insects. Hypothetically, small birds and some

sensitive birds such as pheasants might receive a lethal dose from direct spraying. Certain songbirds are very sensitive to chlorpyrifos; for example, the LD_{50} of chlorpyrifos to red-winged blackbirds is about 13 mg/kg and to house sparrows, about 10-21 mg/kg.

Table 39. Relative Toxicities[1] of Endrin, Chlorpyrifos, and Permethrin to Terrestrial Mammals and Birds.

	Endrin	Chlorpyrifos	Permethrin
Ring-necked Pheasant	53.4 mg/kg	8-18 mg/kg	13,500 mg/kg
Mouse	2.6 mg/kg[2]	540-650 mg/kg	102 mg/kg
Rabbit	5-10 mg/kg	4000 mg/kg	2000 mg/kg
Mule Deer	6.3-12.5 mg/kg		

[1] LD_{50} (oral dose lethal to 1/2 of the test animals).
[2] Pine Mouse.

The possibility for persistence of endrin in the soil and vegetation, and the resulting contamination of food chains would be mitigated by Alternative 9. Neither chlorpyrifos or permethrin are known to bioaccumulate or pass through food chains. Studies with permethrin and chlorpyrifos applied to domestic animals have shown metabolism and excretion in a moderately short period of time and have indicated that neither chemical is significantly retained or accumulated in tissues.

Aquatic and Semiaquatic Wildlife

Alternative 9 would eliminate the potential for acute and chronic effects of endrin to aquatic and semiaquatic wildlife. However, alternative chemicals will likely be substituted for endrin and these are not without some hazards. Chlorpyrifos, for example, is very toxic to birds. Both alternative chemicals are extremely toxic to fish and any direct application or significant drift to fish bearing waters may result in fish kills (Table 40). Many aquatic invertebrates are highly sensitive to permethrin and chlorpyrifos. Cases where these chemicals enter waterways via drift, runoff, or misapplication will result in local reductions in portions of the invertebrate fauna.

The potential for endrin to be transferred through aquatic food chains, and to concentrate at higher levels, would be mitigated by Alternative 9. This mechanism may be partially responsible for the endrin residues detected in waterfowl. There is no evidence of long term persistence or concentration of chlorpyrifos or permethrin in aquatic or semiaquatic organisms.

Table 40. Acute Toxicities of Endrin, Chlorpyrifos, and Permethrin to Mallard Ducks, Selected Fish, and Crayfish.

	Endrin	Chlorpyrifos	Permethrin
Rainbow Trout[1]	0.0018 ppm	0.02 ppm	0.003 ppm
Channel Cat[1]		0.16 ppm	0.001 ppm
Bluegill[1]	0.0003 ppm	0.003 ppm	
Red Crayfish[1]	0.3 ppm	0.04 ppm	
0.0004 ppm			
Mallard Duck[2]	5.6 mg/kg	70-80 mg/kg	

[1] LC_{50} (concentration in water that killed 1/2 of the test animals).
[2] LD_{50} (oral dose that killed 1/2 of the test mallards).

The 1983 labels for permethrin and chlorpyrifos contain restrictions and precautions intended to reduce hazards to aquatic organisms. Direct application to any body of water is prohibited, as is contamination of waters with waste pesticide or water from cleaning application equipment. A buffer zone of 200 feet for aerial applications and 50 feet for ground applications is recommended for permethrin.

Water Quality

The introduction of endrin into bodies of water is significant in terms of acute effects to aquatic organisms and long term contamination of aquatic ecosystems. There is no information to indicate that endrin use has ever presented any problems in municipal drinking water or in ground waters. Alternative 9 would eliminate the potential introduction of endrin into aquatic systems.

Both permethrin and chlorpyrifos apparently have the same potential for entry into bodies of waters and by the same routes as endrin. Both appear to be eliminated fairly rapidly from waters by adsorption to soil particles and transfer to the sediment-water interface. No problems would be anticipated for these two chemicals in municipal water supplies or in ground water.

Aquatic Sediments

The use of endrin may result in residues in aquatic sediments that are still measurable 55 weeks after application to nearby grain fields. These residues probably are a source of endrin into food chains and the resultant transfer to higher levels. The potential for this situation would be mitigated by Alternative 9.

The chemical alternatives to endrin do not have the persistent characteristics of chlorinated hydrocarbons. Chlorpyrifos and permethrin can enter aquatic systems in the same ways as endrin. When this occurs, they have an affinity for sediments. Available information indicates that residues will dissipate in a moderately short time without being transferred through food chains or bioaccumulated.

Soil Quality

The use of endrin in Montana in 1981 resulted in low-level residues still detectable in soil 55 weeks after application (average 0.016 ppm). Cancellation of the registration of endrin would obviously alleviate this situation.

Degradation of chlorpyrifos and permethrin in soils is moderately rapid. Studies indicate that permethrin has a half life of 3-4 weeks in most soils but that it can persistent longer in highly organic soils. Chlorpyrifos has a similar pattern of degradation in soils with the major portion being lost within 6 weeks; however, a small fraction may persist for a year or more. Like permethrin, maximum persistence of chlorpyrifos is associated with organic or muck soils which are not typical of most Montana grain producing regions.

Vegetation Quality

Endrin application to grain in 1981 resulted in foliage residues that were toxicologically significant for several weeks and detectable for 55 weeks after application in stubble and regrowth. Vegetation in areas treated with endrin is unfit for grazing for longer than one year, and may be a source of the endrin residues found in terrestrial wildlife in Montana.

Alternative 9 would significantly improve the quality of vegetation in treated fields. Chlorpyrifos residues should not persist long in plants. About 90-99% of initial residues of chlorpyrifos are lost within 10 days with the remainder being relatively stable. Permethrin is described as nonsystemic and moderately persistent on vegetation; however, the available information is insufficient to generalize on the longevity of residues on vegetation. Grain treated with permethrin cannot be harvest for forage and cannot be grazed until after the harvest of the grain. Grain treated with chlorpyrifos can be used for forage 28 days after application.

Air Quality

The high levels of endrin that result in the immediate area of application sites are not a significant health problem if label directions are followed. Alternative 9 would replace the use of endrin with alternative chemicals such as chlorpyrifos and permethrin, each of which should not significantly impact air quality under correct usage.

Endangered Wildlife

Alternative 9 would relieve the potential problems associated with endrin residues in the diets of bald eagles, peregrine falcons, whooping cranes, and gray wolves. There is no evidence that chlorpyrifos or permethrin pose any risk to the peregrine falcon, bald eagle, or gray wolf. The application or drift of either chemical to fish bearing waters may result in fish kills; however, dead fish are not likely to pose any threat of secondary poisoning to bald eagles.

The LD_{50} of chlorpyrifos to the sandhill crane is 25-50 mg/kg indicating a remote possibility that a diet of moribund or dead invertebrates resulting from chlorpyrifos may be hazardous to whooping cranes.

Recreational Activities and Spending

Alternative 9 will mitigate the endrin contamination of upland game birds and migratory waterfowl that occured in Montana. Even though the endrin contamination of waterfowl will be alleviated, these birds will continue to obtain endrin residues during migratory flights and at wintering areas south of Montana. Endrin is registered and used in the states south of and surrounding Montana. Reportedly, there has been no major use of endrin in Canada since 1972 (although endrin is still registered) so fall migrants should not contain high residues. Further monitoring of endrin residues in geese and ducks may be necessary to inform hunters whether continued warnings on consumption are needed.

Agricultural Production

Assuming that alternative pesticides continue to be as effective against cutworms as data now indicate and that the products are available, no changes in the quantity of agricultural production would be anticipated.

It should be reiterated that the availability of chlorpyrifos, permethrin, and other potential candidates is a question at this time. None are yet federally registered and, until such registration is granted, yearly authorization from the EPA must be obtained via the Section 18 process (FIFRA, as amended) for use in small grains.

Personal Income

At this time the available alternatives to endrin are competitively priced and appear to be effective in controlling cutworms. If registrations or authorizations to use the now available alternatives were withheld endrin use could be reinstated. For these reasons no changes in the personal income of grain growers would be expected to result from Alternative 9.

Human Health

Alternative 9 would significantly reduce the potential health hazards related to the teratogenic effects of endrin and the consumption of wildlife containing endrin residues. However, migratory waterfowl may still contain endrin residues that were encountered along migration routes or in wintering areas. The incidence or level of these residues cannot be determined without further monitoring, nor can the significance of these residues to human health be determined.

In terms of registration of chlorpyrifos and permethrin, some questions still remain on human health issues and the establishment of tolerances for small grains. Until these questions are answered full federal registration cannot be assured nor can the issue of human health be fully addressed.

Local and State Taxes or Fees

The detection of endrin residues in waterfowl and upland game birds may have been a factor influencing the decline in bird hunting during 1981. This resulted in a reduction of bird license fees to the Department of Fish, Wildlife and Parks. Alternative 9 may resolve some or all of this problem.

Government Services

Alternative 9 would reduce the extra work load of several state agencies which dealt with the endrin controversy allowing them to return to other statutory duties and responsibilities.

APPENDICES

Appendix I.

Endrin Labels

VELSICOL

ENDRIN 1.6 EC

AGRICULTURAL INSECTICIDE

CTIVE
NGREDIENTS:
Endrin 19.7%
Xylene Range Aromatic
Solvent 74.5%
NERT
NGREDIENTS: 5.8%
TOTAL 100.0%

Hexachloroepoxyoctahydro-endo, endo-dimethanonapthalene

24(c) SPECIAL LOCAL NEED LABELING

CONTAINS 1.6 POUNDS ENDRIN PER GALLON

KEEP OUT OF THE REACH OF CHILDREN

SEE SIDE PANELS FOR STATEMENT OF PRACTICAL TREATMENT AND ADDITIONAL PRECAUTIONARY STATEMENTS

EPA Reg. 876-153-AA
EPA Est. No. 876—TN—1

PRECAUTIONARY STATEMENTS
Hazards to Humans and Domestic Animals

DANGER

POISON

Poisonous if swallowed, inhaled or absorbed through skin. Do not breathe spray mist. Do not get in eyes, on skin or on clothing.

STATEMENT OF PRACTICAL TREATMENT

If on skin: Remove by washing with soap and water. Get medical attention.

If in eyes: Flush the eyes with clean water for 10 minutes. Get medical attention.

If inhaled: Remove victim to fresh air. Transport immediately to emergency treatment facility.

If swallowed and victim is conscious and not convulsing: Call a physician immediately. Give a glass or two of water and induce vomiting by touching back of throat with finger. It is preferable to induce vomiting under medical supervision or to use gastric lavage with a cuffed endotracheal tube because of aspiration hazard. Remove victim immediately to emergency treatment facilities.

If swallowed and victim is unconscious: Clear the upper airway and if victim is not breathing, administer mouth-to-mouth resuscitation. If heart beat is absent, administer cardiac resuscitation. Do not give anything by mouth. If convulsing, hold head back with jaw forward to keep upper airway clear. Transport immediately to emergency treatment facility, maintaining clear airway and administering artificial respiration.

INFORMATION FOR PHYSICIANS

Endrin is a CNS depressant and hepatotoxin. Toxic dosage causes convulsions, respiratory depression, and liver damage. Impaired respiration must be supported by oxygen given by mechanical ventilation. Diazepam is useful in controlling convulsions. Intravenous glucose and B vitamins help to protect the liver. There is no specific antidote. Do not give vegetable oils or milk (which increase GI absorption). Large amounts of activated charcoal and saline laxatives help to limit GI absorption. Do not give adrenergic agents (myocardial irritability). Excretion of endrin from the body may require days or weeks.

WORK SAFETY RULES

Wear clean synthetic gloves and a mask or a pesticide respirator jointly approved by the Mining Enforcement and Safety Administration (formerly the U.S. Bureau of Mines) and by the National Institute for Occupational Safety and Health under the provisions of 30 CFR Part II. Wash thoroughly with soap and water after handling and before eating or smoking. Wear clean clothing daily.

Required Clothing For Female Workers

Female ground applicators, mixers and loaders and flagpersons must wear long-sleeved shirts and long pants made of a closely woven fabric, and wide-brimmed hats. Mixers and loaders must also wear rubber or synthetic rubber boots and aprons.

Warning to Female Workers

The United States Environmental Protection Agency has determined that endrin causes birth defects in laboratory animals. Exposure to endrin during pregnancy should be avoided. Female workers must be sure to wear all protective clothing and use all protective equipment specified on this label. In case of accidental spills or other unusual exposure, cease work immediately and follow directions for contact with endrin.

ENVIRONMENTAL HAZARDS

This pesticide is toxic to fish and wildlife. Birds and other wildlife in treated areas may be killed. Keep out of lakes, ponds, and streams. Do not contaminate water by cleaning of equipment or disposal of wastes. Do not apply where runoff is likely to occur.

This pesticide is toxic to bees exposed to direct application. Application should be timed to coincide with periods of minimum bee activity, usually between late evening and early morning.

STORAGE AND DISPOSAL

PROHIBITIONS
Do not contaminate water, food or feed by storage, disposal or the cleaning of equipment. Open dumping is prohibited.

PESTICIDE DISPOSAL
Pesticide, spray mixture or rinsate that cannot be used or chemically reprocessed should be disposed of in a landfill approved for pesticides or buried in a safe place away from water supplies.

CONTAINER DISPOSAL
For less than 30 gallons: Triple rinse, and offer for recycling, reconditioning, or disposal in approved landfill, or bury in a safe place.
For 30 gallons or larger: Reseal container and offer for reconditioning OR triple rinse and offer for recycling, reconditioning or disposal in an approved landfill, or bury in a safe place.

GENERAL
Consult Federal, State or Local disposal authorities for approved alternative procedures.

Procedures to Follow If Fish Kills Occur or If Ponds Are Contaminated

In case of fish kills, fish must be collected promptly and disposed of by burial. Ponds in which fish kills have occurred, and user-owned ponds exposed to endrin by application at distances closer than otherwise prohibited, must be posted with signs stating: "Contaminated: No Fishing". Signs must remain for one year after a fish kill has occurred or for six months after lesser contamination unless laboratory analysis shows endrin residues in the edible portion of fish to be less than 0.3 parts per million (ppm).

PHYSICAL OR CHEMICAL HAZARDS

Do Not Use, Pour, Spill, or Store Near Heat or Open Flame.

RESTRICTED USE PESTICIDE
FOR RETAIL SALE TO AND USE ONLY BY CERTIFIED APPLICATORS OR PERSONS UNDER THEIR DIRECT SUPERVISION AND ONLY FOR THOSE USES COVERED BY THE CERTIFIED APPLICATOR'S CERTIFICATION.

(continued on reverse side)

VELSICOL CHEMICAL CORPORATION 341 East Ohio Street, Chicago, Illinois 60611

SP-255 ULS 1180

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

MIXING DIRECTIONS

Mix with water by agitation or by circulating the mixture through spray pump and back into the tank. A proper water mixture will have the appearance of a milky emulsion with no free oil on the surface. Agitate before use until a uniform milky emulsion is formed.

If precipitate deposits in cold weather, warm gently with agitation until redissolved before using.

FOR USE IN SMALL GRAINS (Barley, Oats, Rye, Wheat)

Application Restrictions

Do not apply this product within ⅛ mile of human habitation.

Do not apply this product by air within ¼ mile or by ground within ⅛ mile of lakes, ponds or streams. Application may be made at distances closer to ponds owned by the user but such application may result in excessive contamination and fish kills.

Do not apply when rainfall is imminent.

Apply only when wind velocity is between 2 and 10 mph.

Equipment

Ground Application

For use with boom-nozzle ground equipment. Apply at not less than 5 gallons total mixture, water and chemical, per acre. Do not use nozzle liquid pressure at greater than 40 pounds per square inch (psi). Do not use cone nozzle size smaller than one capable of delivering 0.16 gallons per minute (gpm) at 40 psi such as type D2-25 or TX-10, or any other atomizer or nozzle giving smaller drop size.

Aerial Application

Do not apply at less than one gallon total mixture of water and chemical per acre. Do not operate nozzle liquid pressure over 40 psi or with any nozzle smaller than 0.4 gpm or fan angle greater than 65 degrees such as type 6504. Do not use any cone type nozzles smaller than those capable of delivering 0.4 gpm nor whirl plate smaller than #46 such as type D4-46 or any other atomizer nozzle giving smaller drop size. Do not release this material at greater than 10 feet above the crop.

INSECTS AND DIRECTIONS	DOSAGE/ACRE ENDRIN 1.6 EC	LIMITATIONS
Army cutworms and pale western cutworm. Make single application when insects first appear.	1-1¼ pts	Single application only. Do not apply within 45 days of harvest or feeding. Do not graze treated fields. Do not feed threshings to livestock.

FOR USE ON COTTON IN AREAS WEST OF INTERSTATE HIGHWAY #35 ONLY

Application Restrictions

Do not apply this product within ⅛ mile of human habitation.

Do not apply this product by air within ¼ mile or by ground within ⅛ mile of lakes, ponds, or streams. Application may be made at distances closer to ponds owned by the user but such application may result in excessive contamination and fish kills.

Do not apply when rainfall is imminent.

Apply only when wind velocity is between 2 and 10 mph.

Prophylactic Use

Unnecessary use of this product can lead to resistance in pest populations and subsequent lack of efficacy.

Equipment

Ground Application

For use with boom-nozzle ground equipment. Apply at not less than 5 gallons total mixture, water and chemical, per acre. Do not use nozzle liquid pressure at greater than 40 pounds per square inch (psi). Do not use cone nozzle size smaller than one capable of delivering 0.16 gallons per minute (gpm) at 40 psi such as type D2-25 or TX-10, or any other atomizer or nozzle giving smaller drop size.

Aerial Application

Do not apply at less than 2 gallons total mixture of water and chemical per acre. Do not operate nozzle liquid pressure over 40 psi or with any fan nozzle smaller than one capable of delivering 0.4 gpm or fan angle greater than 65 degrees such as type 6504. Do not use any cone type nozzles smaller than those capable of delivering 0.4 gpm nor whirl plate smaller than #46 such as type D-46 or any other atomizer or nozzle giving smaller drop size. Do not release this material at greater than 10 feet above the crop.

INSECTS AND DIRECTIONS	DOSAGE/ACRE ENDRIN 1.6 E.C.	LIMITATIONS
Boll weevil, bollworm For early season apply 1 pt./A. For late season apply 1-2 pts./A.	1-2 pts.	Workers entering treated fields within 5 days after application should be protected. Do not graze dairy animals or animals being finished for slaughter.
Thrips, fleahoppers Early season—apply ⅜ pt./A. Mid season—apply ¾ pt./A Late season—apply 1 pt./A.	⅜-1 pt.	
Brown cotton leafworm, cabbage looper, celery leaftier, cotton leafworm, cutworms, garden webworm, leaf perforator, lygus bugs, rapid plant bug, salt marsh caterpillar, tarnished plant bug Apply when insects are present. Repeat as necessary.	1-2 pts	
Grasshoppers Fall armyworm, garden webworm, Greenhouse leaftier. Apply when necessary.	1¼ pts. 1-1½ pts. 2 pts.	

FOR USE IN APPLE ORCHARDS

Pests For Which This Product May Be Applied

This product may be applied to control the following pests only:

eastern United States—Pine Vole (*Microtus pinetorum*)
western United States—Meadow Vole (*Microtus* species)

Application Restrictions

Do not apply this product within 50 feet of lakes, ponds or streams.

Do not apply this product within 50 feet of areas occupied by unprotected humans.

Do not apply when rainfall is imminent.

Prophylactic Use

Unnecessary use of this product can lead to resistance in the vole population and subsequent lack of efficacy.

Equipment

Apply by ground equipment only.

Use a very coarse spray with minimum pressure necessary to penetrate ground cover. Do not apply as a fine spray. Power air blast equipment must be modified to meet the above application restriction. Consult the State recommendations for acceptable methods of adapting equipment.

PESTS AND DIRECTIONS	DOSAGE/ACRE ENDRIN 1.6 EC	LIMITATIONS
For control of pine vole use 3 pints per 100 gals. water. Boom application: apply 100 gals of spray in a band 11 ft. wide and 670 ft. long on each side of a tree row (350-400 gals. per acre). Hand done application: apply 11 gals. of spray to each under tree area (5.5 gals per side). For control of meadow vole use 2 pints per 100 gals. water. Apply 300 to 350 gals of spray per acre as directed for pine vole control.	8-12 pts.	Make post harvest applications only. Allow a minimum of 2 months before cultivating after spraying during cool periods of autumn in accordance with the State Agriculture Extension Service. Post and otherwise exclude entry to treated orchards for at least 30 days.

LIMITED WARRANTY AND LIABILITY

NOTICE: Read this Limited Warranty and Liability before buying or using this product. If the terms are not acceptable, return it at once unopened.

It is critical that this product be used and mixed only as specified on the label. The laws of a State may make some or all of this paragraph inapplicable or may give you rights in addition to your rights hereunder. Except to the extent prohibited by applicable law, the exclusive remedy of the user or buyer and the limit of liability of this Company or any other Seller for any and all losses, personal injuries or damages resulting from the use of this product, shall be the purchase price paid by the user or buyer for the quantity of product involved. Except to the extent prohibited by State law, there is no warranty, and this Company and other Sellers disclaim all liability for losses, personal injury or damages: (i) arising from any use of this product in a manner or for a purpose not recommended in its label directions, or from mixing this product before use with any substance except as recommended by the product's label, (ii) arising from handling or storage in violation of label instructions, (iii) for all indirect, special or consequential damages, (iv) when not reported to this Company within one year of discovery, and (v) arising from product not used within the label-designated shelf life or four years from date of purchase whichever first occurs. THERE ARE NO IMPLIED WARRANTIES AND NO WARRANTIES OF MERCHANTABILITY OR FITNESS.

RESTRICTED USE PESTICIDE

FOR RETAIL SALE TO AND USE ONLY BY CERTIFIED APPLICATORS OR PERSONS UNDER THEIR DIRECT SUPERVISION AND ONLY FOR THOSE USES COVERED BY THE CERTIFIED APPLICATOR'S CERTIFICATION.

CLEAN CROP®

ENDRIN EC-20

ACTIVE INGREDIENTS	
Endrin (Hexachloroepoxyoctahydro-endo, endo-dimethanonaphthalene	19.50%
Xylene	76.00%
INERT INGREDIENTS:	4.50%
TOTAL	100.00%

Contains 1.6 lbs. Endrin per gallon

KEEP OUT OF REACH OF CHILDREN

DANGER POISON

STOP! READ THE LABEL

CAN KILL YOU
NOT FOR HOME USE

See Side Panel for Statement of Practical Treatment and Additional Precautionary Statements

NET CONTENTS__________U.S. GALLON(S)

EPA REG. NO. 34704-11

MANUFACTURED FOR **PLATTE CHEMICAL CO., Inc.**
150 SO. MAIN STREET, FREMONT, NEBRASKA 68025

PRECAUTIONARY STATEMENTS
HAZARDS TO HUMANS & DOMESTIC ANIMALS
DANGER

Poisonous by Swallowing, Inhalation, or Skin Contact! Do not get in eyes, on skin, or on clothing. Do not breath vapor or spray mist. Wear clean synthetic rubber gloves and a mask or respirator jointly approved by the Mining Enforcement and Safety Administration (formerly the U.S. Bureau of Mines) and by the National Institute of Occupational Safety and Health under the provisions of 30 CFR Part II. Wash thoroughly with soap and water after handling and before eating or smoking; wear clean clothing. Do not allow to drift, or apply to areas occupied by unprotected humans or beneficial animals. Do not contaminate feed and foodstuffs.

ENVIRONMENTAL HAZARDS

This product is toxic to fish and wildlife. Keep out of any body of water.

Birds feeding on treated areas may be killed.

This pesticide is toxic to bees exposed to direct application. Applications should be timed to coincide with periods of minimum bee activity, usually between late evening and early morning.

Do not apply when weather conditions favor drift from area treated.

Do not contaminate water by cleaning of equipment or disposal of wastes.

STATEMENT OF PRACTICAL TREATMENT

If swallowed and victim is conscious and not convulsing:
Call a physician immediately. Give a glass or two of water and induce vomiting by touching the back of throat with finger. It is preferable to induce vomiting under medical supervision or to use gastric lavage with a cuffed endotracheal tube because of aspiration hazard. Remove victim immediately to emergency treatment facility.

If swallowed and victim is unconscious:
Clear the upper airway and administer mouth-to-mouth resuscitation. If heart beat is absent, administer cardiac resuscitation. Do not give anything by mouth. If convulsing hold head back with jaw forward to keep upper airway clear. Transport immediately to emergency treatment facility, maintaining clear airway and administering artificial respiration.

If inhaled: Remove victim to fresh air. Apply artificial respiration if indicated. Get medical attention immediately.

If on skin: Remove contaminated clothing and wash affected areas thoroughly with soap and water. Get medical attention immediately

If in eyes: Flush eyes with water for at least 15 minutes. Get medical attention immediately.

In all cases of poisoning medical attention must be obtained immediately or victim may die.

NOTE TO PHYSICIAN: Endrin is a CNS depressant and hepatotoxin. Toxic dosage causes convulsions, respiratory depression, and liver damage. Impaired respiration must be supported by oxygen given by mechanical ventilation. Diazepam is useful in controlling convulsions. Intravenous glucose and B vitamins help to protect the liver. There is no specific antidote. Do not give vegetable oils or milk (which increase GI absorption). Large amounts of activated charcoal help to limit GI absorption. Do not give adrenergic agents (myocardial irritability). Excretion of endrin from the body may require days or weeks.

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

P c/c

STORAGE AND DISPOSAL

PROHIBITIONS: Do not contaminate water, food, or feed by storage or disposal. Open dumping is prohibited.

PESTICIDE DISPOSAL: Pesticide, spray mixture, or rinsate that cannot be used or chemically processed should be disposed of in a landfill, approved for pesticides or buried in a safe place away from water supplies.

CONTAINER DISPOSAL: (a) Reseal container and offer for reconditioning, or (b) Triple rinse (or equivalent) and: offer for recycling, reconditioning, or disposal in approved landfill, or bury in a safe place.

GENERAL: Consult Federal, State or Local Disposal Authorities for approved alternative procedures.

STORAGE: Flammable. Keep away from heat or open flame. Keep container closed. Leaking packages should be removed to a safe place. Do not store below 0°F.

REQUIRED CLOTHING FOR FEMALE WORKERS

Female ground applicators, mixers and loaders and flagpersons must wear long-sleeved shirts and long pants made of a closely woven fabric, and wide-brimmed hats. Mixers and loaders must also wear rubber or synthetic rubber boots and aprons.

WARNING TO FEMALE WORKERS

The United State Environmental Protection Agency has determined that endrin causes birth defects in laboratory animals. Exposure to endrin during pregnancy should be avoided. Female workers must be sure to wear all protective clothing and use all protective equipment specified on this label. In case of accidental spills or other unusual exposure, cease work immediately and follow directions for contact with endrin.

EQUIPMENT

Ground application.—For use with boom-nozzle ground equipment. Apply at not less than 5 gallons total mixture, water and chemical, per acre. Do not use nozzle liquid pressure at greater than 40 psi (pounds per square inch). Do not use cone nozzle size smaller than 0.16 gallons per minute (gpm) at 40 psi such as type D2-25 or TX-10, or any other atomizer or nozzle giving smaller drop size.

Aerial application.—Do not apply at less than one gallon total mixture of water and chemical per acre. Do not operate nozzle smaller than 0.4 gallons per minute (gpm) or fan angle greater than 65 degrees such as type 6504. Do not use any cone type nozzles smaller than 0.4 gpm nor whirl plate smaller than no. 46 such as type D4-46 or any other atomizer or nozzle giving smaller drop size. Do not release this material at greater than 10 ft. height above the crop.

APPLICATION RESTRICTIONS

Do not apply this product within 1/8 mile of human habitation.

Do not apply this product by air within ¼ mile or by ground within 1/8 mile of lakes, ponds or streams. Application may be made at distances closer to ponds owned by the user but such application may result in excessive contamination and fish kills.

Do not apply when rainfall is imminent.

Apply only when wind velocity is between 2 mph and 10 mph.

PROCEDURES TO BE FOLLOWED IF FISH KILLS OCCUR OR IF PONDS ARE CONTAMINATED

In case of fish kills, fish must be collected promptly and disposed of by burial. Ponds in which fish kills have occurred, and user-owned ponds exposed to endrin by application at distances closer than otherwise prohibited, must be posted with signs stating: "Contaminated: No Fishing." Signs must remain for one year after a fish kill has occurred or for six months after lesser contamination unless laboratory analysis shows endrin residues in the edible portions of fish to be less than 0.3 part per million (ppm).

[redacted]

PESTS FOR WHICH THIS PRODUCT MAY BE APPLIED

This product may be applied to control the following pests only: army cutworm and pale western cutworm.

DO NOT USE IN UNDILUTED FORM.

To prepare the spray mixture, measure out the required amount of this material and add it to the proper amount of water. Mix thoroughly and apply, agitating continuously. In cold weather this material may deposit a precipitate in the container. Before mixing in this case, the material should be warmed gently and agitated until redissolved. Application should be made at the recommended dosage per acre in sufficient water to provide uniform coverage.

When applying this material by aircraft, mix the recommended amounts with sufficient water to provide a minimum for 1 gallon of finished spray per acre. Care should be taken that this material is not allowed to drift onto neighboring crop or non-crop areas.

OBSERVE INTERVAL BETWEEN LAST APPLICATION AND HARVEST.

BARLEY, OATS, RYE, WHEAT: Army Cutworms and Pale Western Cutworms—APPLY A SINGLE APPLICATION using 1 to 1¼ pints per acre when insects first appear. DO NOT TREAT WITHIN 45 DAYS OF HARVEST. DO NOT GRAZE LIVESTOCK ON TREATED FORAGE. DO NOT FEED THRESHING TO LIVESTOCK.

DEALERS SHOULD SELL IN ORIGINAL PACKAGES ONLY.

USAGE CAUTION: DO NOT ALLOW THIS MATERIAL TO DRIFT ONTO NEIGHBORING CROP OR NON-CROP AREAS OR USE IN A MANNER OR AT A TIME OTHER THAN IN ACCORDANCE WITH DIRECTIONS, BECAUSE PLANT INJURY, EXCESSIVE RESIDUES OR OTHER UNDESIRABLE RESULTS MAY OCCUR.

NOTICE

Platte Chemical Co., Inc., warrants that this material conforms to the chemical description on the label and is reasonably fit for the purposes referred to in the directions for use. This product is sold with the understanding that the buyer assumes all risks of use or handling which may result in loss or damage which are beyond the control of the seller, such as incompatibility with other products, the manner of its use or application, or the presence of other products or materials in or on the soil or crop. Platte Chemical Co., Inc. or any other seller, for any and all losses, injuries, or damages resulting from the use or handling of this product shall be the purchase price paid by the user or buyer for the quantity of this product involved. The buyer and all users are deemed to have accepted the terms of this notice, which may not be varied by any verbal or written agreement.

11R00

Appendix II.

A Comparative Field Test of Endrin, Chlorpyrifos and Permethrin for Controlling Pale Western Cutworm, *Agrotis orthogonia* Morrison in Montana.

A COMPARATIVE FIELD TEST OF ENDRIN, CHLORPYRIFOS AND PERMETHRIN FOR CONTROLLING PALE WESTERN CUTWORM, *AGROTIS ORTHOGONIA* MORRISON IN MONTANA

by
Oakford Bain, Entomologist

Montana Department of Agriculture
Environmental Management Division

Technical Bulletin 83-1

A COMPARATIVE FIELD TEST OF ENDRIN, CHLORPYRIFOS AND PERMETHRIN FOR CONTROLLING PALE WESTERN CUTWORM, *AGROTIS ORTHOGONIA* MORRISON IN MONTANA

by
Oakford Bain
Entomologist

Montana Department of Agriculture
Environmental Management Division

Introduction

The pale western cutworm, *Agrotis orthogonia* Morrison, has been considered one of the most serious pests of small grains in Montana since the initial outbreak of 1917-1920 (Parker et. al. 1920, 1921; Cook 1924). The subterranean feeding habits of the larvae made control with conventional poison baits ineffective (Cook 1930). It was not until the development of the synthetic organochlorine insecticides in the early 1940's that scientists and farmers were given hope of chemically controlling the pest. Brown et. al. (1947) conducted some of the first testing of these new chemicals on pale western cutworm and found lindane (gammexane) to be superior. Interestingly, he showed that pyrethrin was the most toxic of the compounds tested by weight but unstable under field conditions.

Over the next decade a number of organochlorine compounds were developed and tested successfullyagainst the pale western cutworm, however, with the exception of endrin, all were discontinued because of environmental residue hazards (Jacobsen et.al. 1952, Hoerner 1953, Pfadt 1956, Depew and Harvey 1957). Recently, endrin has come under scrutiny for similar reasons (EPA 1979, Bain 1981). In an effort to find more effective, less persistent and safer chemicals for pale western cutworm reduction, considerable attention has been given in the laboratory and field to organophosphate, carbamate and synthetic pyrethroid products. Evaluations by McDonald (1969, 1981) and Depew (1975) indicate that chlorpyrifos and permethrin are among the more promising alternatives. Chlorpyrifos has been registered in Canada for control of pale western cutworm since 1977 (McDonald 1981), however, only limited information is available concerning its performance under operational field conditions. Similarly, permethrin requires large scale field testing. This report presents results of operational field tests of these products in controlling pale western cutworm.

Materials and Methods

In 1982, three small grain study areas infested with pale western cutworm were selected. The primary study site was located 60 miles north of Billings, Montana and involved a several thousand acre infestation in winter wheat and barley. The second site was located some 40 miles to the west at Shawmut, Montana, and the third site was located about 15 miles north of Great Falls, Montana. Both the second and third sites involved marginally economic infestations in winter wheat.

Plot sizes were 40 acres each with the exception of the Shawmut site where only two 20 acre fields were available. The chemicals and rates tested were: Endrin 1.6 E.C. (Velsicol Corp.), 0.25 lb. AI/Acre; Lorsban 4 E (chlorpyrifos - Dow Chemical), 0.5 and 1.0 lb. AI/Acre; Pounce (permethrin - FMC Corp.) 0.1 lb. AI/Acre; Ambush (permethrin - ICI Americas) 0.1 lb. AI/Acre. All treatments were applied by a fixed wing aircraft in two gallons of water per acre.

A comparative test of all three active ingredients was performed at the Billings site because of the larger infestation. Single chemical treatments were applied at Shawmut (Lorsban, 0.5 lb. AI/Acre) and Great Falls (Ambush, 0.1 lb. AI/Acre). The test blocks were randomly assigned and included one replication of each test. Check blocks consisted of two 10 ft. X 20 ft. areas randomly located within each of the test blocks. The checks were constructed by using four inch wide aluminum lawn edging buried at least two inches in the soil to outline the area. Prior to treatment these check blocks were covered with polyethylene sheeting to prevent chemical contamination. The sheeting was removed immediately after treatment.

Determination of cutworm larval densities was made in all treatment and check blocks one day prior to application and three days, seven days and fourteen days post application. Sampling consisted of counting the live larvae in six random square foot soil samples in each check plot and eighteen random square foot samples in each treatment block. Temperature and precipitation records were collected at each site periodically throughout the two week test period. The percentage reduction in larvae for each treatment was adjusted to account for control mortality using a modified Abbotts formula as described by Henderson and Tilton (1955). Differences between treatments and check means were analyzed by Duncans multiple range test (Brunig and Kintz, 1977).

In addition to the efficacy testing conducted at each site, chemical residue degradation was monitored by collecting a series of soil, wheat or barley foliage and native grass (field margins) samples. These samples were collected prior

to treatment, within 12 hours post treatment and then three days, one week, two weeks, six weeks and twelve weeks post application. The last sample included mature grain just prior to harvest.

Residue samples were collected along a predetermined transect through each plot. Soil samples were collected by skimming the top 1½ inches of soil with a clean acetone rinsed trowel and placing the sample into a clean acetone rinsed one quart glass jar. The lid was then foil lined and placed securely on the jar. Foliage samples were collected by grasping a handful of foliage with a clean latex gloved hand and cutting off at ground level with a acetone rinsed knife being careful not to include soil or root tissue. These samples (minimum of 50 grams each) were placed into poly bags and sealed. All samples were placed on ice and delivered to the laboratory within 48 hours where they were frozen until chemical extraction.

Prior to chemical extraction at the laboratory, each soil and vegetation sample was mixed and subsampled to represent a composite sample for each site. Currently accepted Environmental Protection Agency and Food and Drug Administration analytical methods were used. Soil extractions were made with acetone and hexane and vegetation extractions with water-acetonitrile. Residues were measured by gas chromatography utilizing specific GLC detectors. Detection limits were 0.01 parts per million (ppm) for permethrin and chlorpyrifos and 0.001 ppm for endrin.

Results and Discussion

Weather conditions at the Billings and Shawmut sites were ideal on May 31, the day of application. Mid-day temperatures reached 55 degrees and no precipitation was recorded. The Great Falls site was treated on June 2 and weather conditions were less than optimal with temperatures in the 40 - 50 degree fahrenheit range and a light rain falling. The foliage and soil were wet at the time of application. Cool temperatures prevailed at all sites throughout the 14 day post application period. Precipitation totals for the period totaled 2.45 inches at the Billings site, 1.59 inches at Shawmut and 0.67 inches at the Great Falls site.

Table I lists the results of efficacy tests at the Billings site. Cutworm larvae were predominantly in the 4 - 6 instar at the time of treatment. All three compounds significantly reduced cutworm densities three days post application.

Permethrin (Pounce 3.2 E.C.) at 0.1 lb. AI/Acre showed the greatest initial reduction (82%). Endrin at 0.25 lb. AI/Acre and chlorpyrifos (Lorsban 4 E) at 1.0 lb. AI/Acre did not differ significantly. Endrin showed only a slightly

greater reduction (65% compared to 62%). This pattern remained unchanged through the 14 day post application period with permethrin ultimately showing a reduction of 85% and endrin and chlorpyrifos each showing a reduction of 75%.

Table I. Effectiveness of three chemicals applied to winterwheat and barley to control pale western cutworm. Billings, Montana. 1982.

Chemical	lb. AI/ Acre	Pretreatment Mean No. Larvae/ Sq. Ft.[a]	Days Between Application and Sampling: 3 Mean No. Larvae/ Sq. Ft.[b]	3 % Reduction[c]	7 Mean No. Larvae/ Sq. Ft.	7 % Reduction	14 Mean No. Larvae/ Sq. Ft.	14 % Reduction
Permethrin	0.1	1.8	0.3[a]	82%	0.2[a]	90%	0.3[a]	85%
Chlorpyrifos	1.0	3.5	1.2[b]	62%	0.8[b]	81%	1.0[b]	75%
Endrin	0.25	2.5	0.9[b]	65%	0.9[b]	69%	0.7[ab]	75%
Check	---	2.2	2.0[c]	--	2.3[c]	--	2.6[c]	--

[a]Mean No. Larvae/Sq. Ft. average of 2 replicates.

[b]For each test, any 2 means in the same column followed by the same letter are not significantly different at the 5% level (Duncan's multiple range test).

[c]Percent reduction corrected to account for control mortality by modified.

Table II lists the results of the chlorpyrifos test at Shawmut. The application rate on these plots (0.5 lb. AI/Acre) was half that on the Billings plots yet larval reduction was 81%, 91% and 90% respectively at 3, 7 and 14 days post application. This difference in control might be explained by the 0.9 inch less rainfall on the Shawmut plots and the lower percentage of organic matter in the Shawmut soils. Larval growth stage was similar at both sites. Table III lists the results of the permethrin (Ambush) test at Great Falls. Although larval densities were subeconomic at this site the percent reduction at 14 days post application was closely comparable to the results recorded at the Billings site. Initial reduction was somewhat lower at the Great Falls site (58% at 3 days) but this could be explained by reduced larval activity due to the inclement weather. It appears from these results that application under wet conditions had little or no effect on the level of control at 14 days with permethrin.

Table II. Effectiveness of chlorpyrifos in reducing pale western cutworm infesting winterwheat. Shawmut, Montana. 1982.

Chemical	lb. AI/ Acre	Pretreatment	Days Between Application and Sampling					
			3		7		14	
		Mean No. Larvae/ Sq. Ft.	Mean No. Larvae/ Sq. Ft.	% Reduction[a]	Mean No. Larvae/ Sq. Ft.	% Reduction	Mean No. Larvae/ Sq. Ft.	% Reduction
Chlorpyrifos	0.5	1.6	0.3	81%	0.1	91%	0.1	90%
Check	---	1.8	1.8	--	1.3	--	1.1	--

[a]Mortality data adjusted using modified Abbotts formula.

Table III. Effectiveness of permethrin in reducing pale western cutworm infesting winterwheat. Great Falls, Montana. 1982.

Chemical	lb. AI/ Acre	Pretreatment	Days Between Application and Sampling					
			3		7		14	
		Mean No. Larvae/ Sq. Ft.	Mean No. Larvae/ Sq. Ft.	% Reduction[a]	Mean No. Larvae/ Sq. Ft.	% Reduction	Mean No. Larvae/ Sq. Ft.	% Reduction
Permethrin	0.1	0.5	0.09	58%	0.04	88%	0.02	92%
Check	---	0.5	0.3	--	0.4	--	0.3	--

[a]Mortality data adjusted using modified Abbotts formula.

Table IV lists the results of residue testing for each of the study sites. As might be expected, endrin was the most persistent of the chemicals tested. Endrin residues in soil at two weeks post application had degraded from those measured 12 hours post application by approximately 24% and in wheat vegetation by 99.2%. Soil residues continued to degrade to 35% at six weeks and 54% at 12 weeks post application. Vegetation residues degraded more quickly with 99.9% of the endrin parent compound detectable 12 hours after treatment degraded at the twelve week post application period.

Permethrin residues measured as combined cis-and trans-isomers degraded rapidly. Approximately 80% of the residue level measured in soil within a few hours of treatment had degraded by the two week post treatment period. Between 70% and 99% of the permethrin residues had degraded on the vegetation during the same period. By six weeks post application permethrin residues on soil and vegetation had degraded by 97-99% on the Ambush plots and were below the detection limit on the Pounce plots.

Chlorpyrifos residues followed a degradation pattern similar to permethrin. Residues measured at the six week post application period ranged from None Detected to 99.3% degradation of the residues measured on soil and vegetation within one to three hours of application. At twelve weeks post application no chlorpyrifos residues were detected in soil samples and levels equaling the detection limit were found in wheat straw. No residues of endrin, chlorpyrifos or permethrin were detected in grain kernels collected at harvest.

The results of these tests tend to confirm laboratory and small plot studies previously reported. Both chlorpyrifos and permethrin performed equal or superior to endrin in reducing pale western cutworm larval numbers under spring weather conditions typical of central Montana. While all three chemicals degraded at approximately the same rates on the small grain foliage, endrin demonstrated a much slower degradation rate in the soil. It is true that chemical residue degradation can vary dramatically under different environmental conditions, yet the results of this study indicate that neither chlorpyrifos or permethrin would be as persistent as endrin.

Additional testing of chlorpyrifos and permethrin at reduced rates should be done. Since the economics of application can be a major factor in chemical selection by the applicator or producer, proven effectiveness of these two alternative chemicals at reduced rates might make them more competitive with endrin. Further testing of both chemicals under dry soil conditions typical of an outbreak year should also being performed.

Table IV. Results of residue analysis for 1982 field tests of endrin, chlorpyrifos and permethrin for control of pale western cutworm.

Product	lb. AI/ Acre	Tank Mix % Claim	Residues (ppm)[a] 12 Hours Post Treatment Soil		3 Days Post Treatment Soil		1 Week Post Treatment Soil	
			Soil	Wheat Foliage	Soil	Wheat Foliage	Soil	Wheat Foliage
Endrin	0.25	113	0.78 (1.0-0.56)	21.5 (16-27)	0.81 (0.63-0.98)	6.1 (2.7-9.5)	0.55 (0.41-0.69)	3.75 (2-5.5)
Chlorpyrifos	1.0	87	2.93 (1.7-4.3)	70.0 (65-77)	4.5 (3.5-5.5)	21 (20-22)	0.66 (0.37-.95)	3.5 (2.7-4.3)
Chlorpyrifos	0.5	93	4.2 (2.1-6.3)	145.0 (119-171)	2.65 (1.7-3.6)	20.5 (11.0-30.0)	1.17 (0.94-1.4)	7.85 (5.5-10.2)
Permethrin[b] (Pounce)	0.1	65	0.20 (.11-.3)	4.63 (1.3-7.0)	0.11 (.065-.16)	2.6 (1.9-3.8)	0.04 (.029-.048)	0.62 (0.49-0.78)
Permethrin[b] (Ambush)	0.1	108	0.36 (0.15-0.21)	5.45 (4.5-6.6)	0.13 (0.1-0.17)	4.68 (2.6-7.2)	0.27 (0.21-0.32)	3.15 (1.6-5.2)

Table IV. Continued

	Residues (ppm)[a] 2 Weeks Post Treatment		6 Weeks Post Treatment		12 Weeks Post Treatment		
	Soil	Wheat Foliage	Soil	Wheat Foliage	Soil	Wheat Straw	Grain Kernels
Endrin	0.59 (0.37-0.80)	0.18 (.13-.22)	0.51 (0.34-0.68)	0.02 (.01-.028)	0.36 (0.14-0.58)	.062 (.023-.1)	N.D.
Chlorpyrifos	0.37 (0.32-0.41)	0.56 (0.12-1.0)	0.02 (0.01-0.03)	N.D.	N.D.	.01 (N.D.-.02)	N.D.
Chlorpyrifos	0.27 (0.14-0.39)	1.15 (1.0-1.3)	0.03 (0.012-.037)	0.14 (0.19-.011)	N.D.	.01 (N.D.-.011)	N.D.
Permethrin[b] (Pounce)	0.04 (.028-.049)	.03 (.017-.047)	N.D.	N.D.	N.D.	N.D.	N.D.
Permethrin[b] (Ambush)	0.08 (0.054-.011)	1.62 (0.5-1.2)	.01 (N.D.-.027)	.05 (0.043-0.055)	N.D.	0.56 (0.3-0.87)	N.D.

[a]Residues represent an average of two composites. The range of residues appears in parentheses.
[b]Permethrin residues expressed as total cis and trans isomers.

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Appendix III.

Raw Data for Analysis of
Wildlife Tissue for Endrin in 1981 and 1982

Provided By:

Montana Department of Fish, Wildlife and Parks

(see key on pages 161 and 162)

Wildlife Tissue Sample Results

RL#	SPP	A/S	T	MOYR	CTY	ENDRN	KETO
184	PHT	ADF	F	0482	021	00.01	
204	PHT	ADF	F	0482	021	<0.01	
187	PHT	ADM	F	0582	021	00.02	
214	PHT		E	0582	021	<0.01	
188	PHT	ADF	F	0582	021	00.02	
752	PHT	JVF	F	1082	013	<0.01	
753	PHT	JVM	F	1082	013	<0.01	
754	PHT	ADM	F	1082	013	<0.01	
755	PHT	JVM	F	1082	013	<0.01	

Count of SPP PHT = 17

RL#	SPP	A/S	T	MOYR	CTY	ENDRN	KETO
594	PKM	ADF	W	1181	025	<.005	<.005

Count of SPP PKM = 1

RL#	SPP	A/S	T	MOYR	CTY	ENDRN	KETO
217	POR	ADF	F	0582	025	<0.01	

Count of SPP POR = 1

RL#	SPP	A/S	T	MOYR	CTY	ENDRN	KETO
172	PTL	ADM	F	0482	015	00.04	
172	PTL	ADM	M	0482	015	0.007	
175	PTL	ADF	F	0482	015	00.10	
175	PTL	ADF	M	0482	015	<.005	
277	PTL	ADF	B	0482	015	<.005	
278	PTL	ADF	G	0482	015	<.005	
155	PTL	ADM	F	0582	017	0.32	
156	PTL	ADM	F	0582	017	0.17	
156	PTL	ADM	M	0582	017	0.006	
279	PTL	ADM	B	0582	017	<.005	
280	PTL	ADM	C	0582	017	0.011	
322	PTL	ADF	F	0782	083	<0.01	
353	PTL	ADF	F	0782	095	<0.01	
354	PTL	ADM	F	0782	095	<0.01	
355	PTL	ADM	F	0782	095	<0.01	
440	PTL	JVM	B	0982	065	<.005	
488	PTL	JVF	F	1082	083	<0.01	
494	PTL	ADM	F	1082	083	<0.01	
500	PTL	ADF	F	1082	083	00.02	
501	PTL	ADM	F	1082	083	00.04	

Count of SPP PTL = 20

RL#	SPP	A/S	T	MOYR	CTY	ENDRN	KETO
575	PVL	ADM	W	1181	021	<.005	<.005
600	PVL	SAF	W	1181	025	<.005	<.005
602	PVL	SAF	B	1181	025	<0.01	<0.01
603	PVL	SAF	L	1181	025	<0.01	<0.01
601	PVL	SAF	W	1181	025	<.005	<.005

Count of SPP PVL = 5

RL#	SPP	A/S	T	MOYR	CTY	ENDRN	KETO
748	RGS	SAM	B	0482	015	<0.01	<0.01
749	RGS	SAM	Y	0482	015	<.005	<.005
750	RGS	SAM	L	0482	015	<.005	<.005
751	RGS	SAM	F	0482	015	<0.01	<0.01
745	RGS	ADM	B	0482	015	<.005	<.005
746	RGS	ADM	L	0482	015	<.005	<.005
747	RGS	ADM	F	0482	015	<0.01	<0.01
688	RGS	ADF	B	0482	015	<.005	<.005
689	RGS	ADF	L	0482	015	<.005	<.005
690	RGS	ADF	F	0482	015	<0.01	<.005

Count of SPP RGS = 10

RL#	SPP	A/S	T	MOYR	CTY	ENDRN	KETO
060	RND	JVM	F	1081	025	<0.01	
061	RND	JVM	F	1081	025	<0.01	
167	RND	ADM	F	0482	067	00.11	
478	RND	ADM	F	0982	067	00.03	

Count of SPP RND = 4

RL#	SPP	A/S	T	MOYR	CTY	ENDRN	KETO
148	RTH	IM	F	1181	087	<0.01	
203	RTH	IM	F	0482	021	<0.01	

Count of SPP RTH = 2

RL#	SPP	A/S	T	MOYR	CTY	ENDRN	KETO
063	RUD	JVM	F	1081	025	<0.01	
308	RUD	ADM	F	0782	067	01.31	
309	RUD	ADF	F	0782	067	02.56	

Count of SPP RUD = 3

Wildlife Tissue Sample Results

RL#	SPP	A/S	T	MOYR	CTY	ENDRN	KETO
743	RWB	ADM	F	0582	021	<0.01	
744	RWB	ADM	B	0582	021	<0.01	
Count	of	SPP	RWB =				2
081	SAG	ADM	F	1181	075	<0.01	
Count	of	SPP	SAG =				1
043	SCP	JVM	F	1081	025	<0.01	
059	SCP	JVM	F	1081	025	<0.01	
164	SCP	ADF	F	0482	015	00.01	
412	SCP	JV	F	0882	015	<0.01	
418	SCP	JV	F	0882	015	<0.01	
420	SCP	JV	F	0882	015	<0.01	
421	SCP	JV	F	0882	015	<0.01	
730	SCP	F	F	1082	071	<0.01	
731	SCP	F	F	1082	071	<0.01	
Count	of	SPP	SCP =				9
445	SED		S	0582	021	<.005	
447	SED		S	0782	065	<.005	
446	SED		S	0782	067	<.005	
448	SED		S	0782	037	<.005	
449	SED		S	0782	065	<.005	
450	SED		S	0782	065	<.005	
451	SED		S	0782	065	<.005	
452	SED		S	0782	065	<.005	
Count	of	SPP	SED =				8
E69	SHV	ADF	F	1081	079	<0.01	
169	SHV	ADM	F	0482	067	00.06	

RL#	SPP	A/S	T	MOYR	CTY	ENDRN	KETO
151	SHV	ADM	F	0582	017	00.07	
151	SHV	ADM	M	0582	017	<.005	
427	SHV	ADF	F	0882	017	00.03	
432	SHV	JVM	F	0882	017	00.02	
Count	of	SPP	SHV =				6
611	SNB	ADM	W	1181	015	<.005	
612	SNB	ADM	B	1181	015	<0.01	
613	SNB	ADM	F	1181	015	<0.01	
614	SNB	ADM	C	1181	015	<.005	
615	SNB	ADF	W	1181	015	<.005	
Count	of	SPP	SNB =				5
216	SNL		W	0482	015	<0.01	
Count	of	SPP	SNL =				1
132	SNP		F	1181	021	<0.01	
Count	of	SPP	SNP =				1
514	SNT	AD	F	0982	025	<0.01	
515	SNT	AD	F	1082	079	<.005	
Count	of	SPP	SNT =				2
X01	STG	ADF	M	0481	017	00.35	
X01	STG	ADF	B	0481	017	00.30	
X01	STG	ADF	F	0481	017	22.90	
X01	STG	ADF	Y	0481	017	02.54	
X03	STG		M	0881	025	0.003	
X21	STG	ADF	F	0981	075	02.02	
X04	STG		F	0981	025	00.03	
X05	STG		F	0981	021	<0.10	
X06	STG		F	0981	021	00.04	

Wildlife Tissue Sample Results

RL#	SPP	A/S	T	MOYR	CTY	ENDRN	KETO
024	STG	JVF	F	1081	017	00.02	
110	STG	JVF	F	1181	015	<0.01	
117	STG	ADM	F	1181	021	<0.01	
120	STG	ADF	F	1181	025	00.21	
186	STG	ADF	F	1181	025	00.22	
119	STG	JVM	F	1181	025	00.22	
128	STG	ADM	F	1181	021	00.03	
129	STG	JVM	F	1181	021	00.04	
130	STG	JVM	F	1181	021	00.03	
131	STG	ADM	F	1181	021	00.04	
133	STG	ADM	F	1181	021	00.03	
134	STG	JVM	F	1181	021	00.03	
135	STG	ADM	F	1181	021	00.03	
136	STG	JVM	F	1181	021	00.03	
513	STG	ADF	F	0082	075	<0.01	
201	STG	ADM	F	0482	021	00.01	
332	STG	JV	F	0782	021	00.01	
326	STG	ADF	F	0782	083	<0.01	
328	STG	ADF	F	0782	083	<0.01	
352	STG	ADF	F	0782	003	<0.01	
433	STG	ADM	F	0882	017	<0.01	
510	STG	JVF	F	0982	017	<0.01	
511	STG	JVM	F	0982	017	<0.01	
512	STG	JVM	F	0982	017	<0.01	
503	STG	ADM	F	0982	017	<0.01	
504	STG	JVM	F	0982	017	<0.01	
506	STG	ADM	F	0982	017	<0.01	
507	STG	ADF	F	0982	017	<0.01	

Count of SPP STG = 37

717	TGS	ADF	B	0582	025	<0.01	<0.01
718	TGS	ADF	L	0582	025	00.14	<0.01
719	TGS	ADF	F	0582	025	<0.01	<0.01
697	TGS	ADM	B	0582	025	<0.01	<0.01
698	TGS	ADM	Y	0582	025	<.005	<.005
704	TGS	ADM	L	0582	025	00.12	0.022
705	TGS	ADM	F	0582	025	<0.01	<0.01

Count of SPP TGS = 7

069	VSS	ADF	W	0482	015	<.005
265	VSS	ADM	W	0782	065	0.078

RL#	SPP	A/S	T	MOYR	CTY	ENDRN	KETO
408	VSS	ADF	W	0782	065	0.027	
409	VSS	ADF	F	0782	065	00.16	
410	VSS	ADF	B	0782	065	<.005	
391	VSS	JV	W	0782	065	0.009	
474	VSS	JVM	W	0882	065	<.005	
475	VSS	ADM	W	0882	065	<.005	
476	VSS	COM	F	0882	065	<0.01	
477	VSS	COM	B	0882	065	<0.01	
791	VSS	JV	W	0982	065	<.005	
780	VSS	ADM	W	0982	065	<.005	
786	VSS	JVM	W	0982	065	<.005	

Count of SPP VSS = 13

700	WCS	ADF	W	0582	021	<.005
701	WCS	ADF	W	0582	021	<.005
702	WCS	ADF	B	0582	021	<0.01
703	WCS	ADF	F	0582	021	<0.01
737	WCS	ADF	W	0582	021	<0.01
738	WCS	ADF	F	0582	021	00.01

Count of SPP WCS = 6

X23	WHT		Z	0981	025	0.026
X24	WHT		U	0981	025	0.095

Count of SPP WHT = 2

422	WPL	ADF	B	0882	111	00.07

Count of SPP WPL = 1

757	WSW	AD	F	1082	099	<0.01
759	WSW	AD	F	1082	099	<0.01
758	WSW	AD	F	1082	099	<0.01
756	WSW	JV	F	1182	099	<0.01

Count of SPP WSW = 4

Wildlife Tissue Sample Results

RL#	SPP	A/S	T	MOYR	CTY	ENDRN	KETO
X16	ANT	03M	F	0881	017	<0.01	
X07	ANT	YRF	F	0881	017	<0.01	
182	ANT	YLM	F	1081	087	<0.01	
183	ANT	FN	F	1081	087	<0.01	
323	ANT	ADM	F	0782	083	<0.01	<0.02

Count of SPP ANT = 5

RL#	SPP	A/S	T	MOYR	CTY	ENDRN	KETO
438	BAR		Z	0982	065	<.005	
439	BAR		Z	0982	037	<.005	

Count of SPP BAR = 2

RL#	SPP	A/S	T	MOYR	CTY	ENDRN	KETO
X17	BDP	COF	B	0981	015	0.042	
X17	BDP	COF	Y	0981	015	0.004	
X20	BDP		F	0981	075	<0.01	
X22	BDP	JVM	B	0981	079	<0.02	
010	BDP	JVM	F	1081	021	00.01	
014	BDP	ADM	F	1081	067	<0.20	
103	BDP	ADM	F	1181	015	00.06	
101	BDP	JVM	F	1181	015	00.01	
166	BDP	ADM	F	0482	015	00.17	
166	BDP	ADM	M	0482	015	0.012	
275	BDP	ADM	B	0482	015	<.005	
276	BDP	ADM	G	0482	015	<.005	
163	BDP	ADM	F	0582	025	00.58	
224	BDP	ADM	F	0582	065	00.14	
226	BDP	ADF	F	0582	065	00.01	
428	BDP	ADF	F	0782	075	<0.01	
283	BDP	ADM	F	0782	037	03.00	
404	BDP	JV	F	0782	033	<0.01	
406	BDP	JVM	F	0782	033	<0.01	
398	BDP	JVM	F	0882	087	<0.01	
400	BDP	JVM	F	0882	087	<0.01	
401	BDP	ADF	F	0882	087	<0.01	
411	BDP	JV	F	0882	015	00.02	
414	BDP	JV	F	0882	015	00.02	
416	BDP	ADF	F	0882	015	00.02	
417	BDP	JV	F	0882	015	00.04	
441	BDP	JVM	F	0982	065	00.06	

Count of SPP BDP = 27

RL#	SPP	A/S	T	MOYR	CTY	ENDRN	KETO
229	BPD	JVM	B	0682	065	00.71	<0.01
472	BPD	JVM	L	0682	065	03.32	<.005
230	BPD	ADM	F	0682	065	00.07	<0.02
267	BPD	ADM	B	0682	065	0.005	<0.02
266	BPD	JVM	F	0782	065	00.24	<0.02
268	BPD	JVM	B	0782	065	<.005	<0.02
316	BPD	ADF	F	0782	065	00.04	<0.02
318	BPD	ADF	B	0782	065	<.005	<0.02
319	BPD	ADF	L	0782	065	0.011	<0.02
337	BPD	JVM	F	0782	065	00.01	<0.01
338	BPD	JVM	B	0782	065	<.005	<.005
340	BPD	JVM	L	0782	065	<.005	<.005
453	BPD	JVM	F	0882	065	<0.01	<0.01
454	BPD	JVM	B	0882	055	<.005	<.005
455	BPD	JVM	L	0882	065	<.005	<.005

Count of SPP BPD = 15

RL#	SPP	A/S	T	MOYR	CTY	ENDRN	KETO
X18	BWT	JVF	Y	0981	015	0.022	
190	BWT	ADM	F	0582	021	00.08	
190	BWT	ADM	M	0582	021	0.008	
193	BWT	ADM	F	0582	021	<0.01	
195	BWT	ADF	F	0582	021	00.02	
222	BWT	ADM	F	0582	065	00.01	
329	BWT	ADF	F	0782	021	00.01	
330	BWT	JV	F	0782	021	00.01	
315	BWT	ADF	F	0782	083	<0.01	
317	BWT	JV	F	0782	083	<0.01	
320	BWT	JV	F	0782	083	<0.01	
321	BWT	JV	F	0782	083	<0.01	
377	BWT	ADM	F	0782	111	<0.01	
378	BWT	JVM	F	0782	111	<0.01	
379	BWT	JVM	C	0782	111	<.005	
380	BWT	ADM	F	0782	111	00.01	
381	BWT	ADM	F	0782	111	00.02	
399	BWT	ADF	F	0882	087	<0.01	
402	BWT	JV	F	0882	087	<0.01	
480	BWT	JVM	F	0982	067	<0.01	

Count of SPP BWT = 20

RL#	SPP	A/S	T	MOYR	CTY	ENDRN	KETO
679	CCL	ADM	W	0482	015	0.011	
680	CCL	ADM	W	0482	015	0.030	

RL#	SPP	A/S	T	MOYR	CTY	ENDRN	KETO
681	CCL	ADM	B	0482	015	<0.01	

Count of SPP CCL = 3

RL#	SPP	A/S	T	MOYR	CTY	ENDRN	KETO
X08	CNG	M	F	0881	017	00.32	
X08	CNG	M	Y	0881	017	0.014	
X09	CNG	JVM	M	0881	017	0.011	
X10	CNG	ADF	F	0881	017	00.31	
X19	CNG	F	F	0981	015	00.08	
X12	CNG	YRM	F	0981	017	00.13	
X13	CNG	JVM	F	0981	017	00.40	
X13	CNG	JVM	B	0981	017	<0.02	
E01	CNG	AD	F	0981	007	00.03	
079	CNG	JVM	F	1181	017	00.07	
080	CNG	JVM	F	1181	017	00.27	
177	CNG		F	1281	087	<0.01	
178	CNG		F	1281	087	<0.01	
179	CNG		F	1281	087	<0.01	
180	CNG		F	1281	087	<0.01	
149	CNG		F	0382	007	<0.01	
150	CNG		F	0382	007	<0.01	
215	CNG		E	0482	007	<0.01	
157	CNG	YLF	F	0582	017	0.10	
160	CNG	ADM	F	0582	021	00.03	
161	CNG	ADF	F	0582	021	00.01	
343	CNG	JV	F	0782	017	00.02	
344	CNG	JV	F	0782	017	<0.01	
345	CNG	JV	F	0782	017	<0.01	
346	CNG	JV	F	0782	017	<0.01	
347	CNG	JV	F	0782	017	<0.01	
348	CNG	AD	F	0782	017	<0.01	
349	CNG	AD	F	0782	017	<0.01	
350	CNG	AD	F	0782	017	<0.01	
425	CNG	JVF	F	0882	017	00.06	
435	CNG	JVF	F	0882	017	00.13	
487	CNG	JVF	F	1082	083	<0.01	
733	CNG	ADF	F	1082	071	<0.01	
762	CNG	JV	F	1082	101	00.02	
720	CNG		F	1082	071	<0.01	
721	CNG		F	1082	071	<0.01	
766	CNG	AD	F	1082	101	<0.01	

Count of SPP CNG = 37

RL#	SPP	A/S	T	MOYR	CTY	ENDRN	KETO
012	COT	JV	F	1081	067	00.03	
013	COT	AD	F	1081	067	00.03	
058	COT	JV	F	1081	025	<0.01	
094	COT	JV	F	1181	111	<0.01	
095	COT	JV	F	1181	111	<0.01	
096	COT	AD	F	1181	111	<0.01	
174	COT	ADF	F	0482	067	00.64	
307	COT	JVM	F	0782	067	00.32	
310	COT	ADM	F	0782	067	00.06	
311	COT	ADF	F	0782	067	00.06	
312	COT	JVM	F	0782	067	00.06	
313	COT	JVF	F	0782	067	00.01	
314	COT	JVM	F	0782	067	00.02	

Count of SPP COT = 13

RL#	SPP	A/S	T	MOYR	CTY	ENDRN	KETO
290	CSW	ADF	W	0782	037	0.012	
291	CSW	ADF	F	0782	037	00.12	
292	CSW	ADF	B	0782	037	00.01	

Count of SPP CSW = 3

RL#	SPP	A/S	T	MOYR	CTY	ENDRN	KETO
139	CTR	ADM	F	0182	021	00.01	
456	CTR	JVF	F	0982	065	00.13	<0.01
457	CTR	JVF	B	0982	065	0.008	<.005
458	CTR	JVF	L	0982	065	0.031	<.005

Count of SPP CTR = 4

RL#	SPP	A/S	T	MOYR	CTY	ENDRN	KETO
228	CUT		W	0682	037	<.005	
473	CUT		W	0682	037	01.06	

Count of SPP CUT = 2

RL#	SPP	A/S	T	MOYR	CTY	ENDRN	KETO
742	CWB	ADM	F	0582	021	<0.01	

Count of SPP CWB = 1

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RL#	SPP	A/S	T	MOYR	CTY	ENDRN	KETO
523	DEM	ADM	W	1181	015	<.005	<.005
525	DEM	ADM	B	1181	015	<0.01	<0.01
526	DEM	ADM	L	1181	015	<0.01	00.02
519	DEM	ADF	W	1181	015	<.005	
521	DEM	COB	L	1181	015	<0.01	00.03
522	DEM	COB	B	1181	015	<0.01	<0.01
524	DEM	ADF	W	1181	015	<.005	<.005
527	DEM	COF	B	1181	015	00.02	<0.01
528	DEM	COF	L	1181	015	00.02	00.02
540	DEM	ADM	W	1181	015	<.005	<.005
541	DEM	ADM	B	1181	015	<0.01	<0.01
542	DEM	ADM	L	1181	015	<0.01	<0.01
543	DEM	ADF	W	1181	015	<.005	00.16
544	DEM	ADF	B	1181	015	<0.01	<0.01
545	DEM	ADF	L	1181	015	<.005	00.12
546	DEM	SAF	W	1181	015	<.005	<.005
547	DEM	SAM	W	1181	015	<.005	<.005
520	DEM	JVM	W	1181	015	<.005	<.005
533	DEM	JVM	W	1181	015	0.005	0.014
549	DEM	ADM	W	1181	021	<.005	<.005
550	DEM	ADM	B	1181	021	<0.01	<0.01
551	DEM	ADM	L	1181	021	<0.01	<0.01
552	DEM	ADF	W	1181	021	<.005	<.005
553	DEM	ADF	B	1181	021	<0.01	<0.01
554	DEM	ADF	L	1181	021	<0.01	<0.01
555	DEM	SAM	W	1181	021	<.005	<.005
556	DEM	SAF	W	1181	021	<.005	<.005
557	DEM	ADF	W	1181	021	<.005	<.005
558	DEM	SAM	W	1181	021	<.005	<.005
559	DEM	COB	B	1181	021	<0.01	<0.01
560	DEM	COB	L	1181	021	<0.01	<0.01
566	DEM	ADM	W	1181	021	<.005	<.005
567	DEM	ADM	B	1181	021	<0.01	<0.01
568	DEM	ADM	L	1181	021	<0.01	<0.01
569	DEM	ADF	W	1181	021	<.005	<.005
570	DEM	ADF	B	1181	021	<0.01	<0.01
571	DEM	ADF	L	1181	021	<0.01	<0.01
572	DEM	SAM	W	1181	021	<.005	<.005
573	DEM	SAF	W	1181	021	<.005	<.005
578	DEM	SAM	W	1181	025	<.005	<.005
580	DEM	ADM	B	1181	025	<0.01	<0.01
581	DEM	ADM	L	1181	025	<0.01	<0.01
586	DEM	SAM	W	1181	025	<0.01	<0.01
587	DEM	SAF	W	1181	025	<0.01	<0.01
588	DEM	ADM	W	1181	025	<0.01	<0.01
589	DEM	ADM	B	1181	025	<0.01	<0.01
590	DEM	ADM	L	1181	025	<0.01	<0.01

RL#	SPP	A/S	T	MOYR	CTY	ENDRN	KETO
591	DEM	ADF	W	1181	025	<0.01	<0.01
592	DEM	ADF	B	1181	025	<0.01	<0.01
593	DEM	ADF	L	1181	025	<0.01	<0.01
597	DEM	COM	B	1181	025	<0.01	<0.01
598	DEM	COM	L	1181	025	<0.01	<0.01
599	DEM	JVF	W	1181	025	<.005	<.005
579	DEM	ADM	W	1181	025	<.005	<.005
595	DEM	ADF	W	1181	025	<.005	<.005
596	DEM	ADM	W	1181	025	<.005	<.005
616	DEM	SAM	W	0482	015	<.005	<.005
617	DEM	SAF	W	0482	015	<.005	<.005
618	DEM	ADM	W	0482	015	<.005	<.005
619	DEM	ADM	B	0482	015	<0.01	<0.01
620	DEM	ADM	L	0482	015	<.005	0.028
621	DEM	ADF	W	0482	015	<.005	<.005
622	DEM	ADF	B	0482	015	<0.01	<0.01
623	DEM	ADF	L	0482	015	<.005	0.006
624	DEM		V	0482	015	<.005	<.005
628	DEM	JVM	W	0482	015	<.005	<.005
629	DEM	ADM	W	0482	015	<.005	<.005
630	DEM	ADM	B	0482	015	<0.01	<0.01
631	DEM	ADM	L	0482	015	<.005	0.041
632	DEM	ADF	W	0482	015	<.005	<.005
633	DEM	ADF	W	0482	015	<.005	<.005
634	DEM	ADF	B	0482	015	<0.01	<0.01
635	DEM	ADF	L	0482	015	<.005	<.005
636	DEM		V	0482	015	<.005	<.005
637	DEM	ADM	W	0482	015	<.005	<.005
638	DEM	ADF	W	0482	015	<.005	<.005
639	DEM	ADF	B	0482	015	<0.01	<0.01
640	DEM	ADF	L	0482	015	<.005	<.005
644	DEM	ADF	W	0482	015	<.005	<.005
645	DEM	ADM	W	0482	015	<.005	<.005
646	DEM	ADM	B	0482	015	<0.01	<0.01
647	DEM	ADM	L	0482	015	<.005	<.005
653	DEM	ADM	W	0582	021	<.005	<.005
654	DEM	ADM	W	0582	021	<.005	<.005
655	DEM	ADM	B	0582	021	<0.01	<0.01
656	DEM	ADM	L	0582	021	<.005	<.005
657	DEM	ADF	W	0582	021	<.005	<.005
658	DEM	ADF	B	0582	021	<0.01	<0.01
659	DEM	ADF	L	0582	021	<.005	<.005
661	DEM	N3B	W	0582	021	<.005	<.005
660	DEM	SAF	W	0582	021	<.005	<.005
670	DEM	ADF	W	0582	021	<.005	<.005
671	DEM	ADF	B	0582	021	<0.01	<0.01
672	DEM	ADF	L	0582	021	<0.01	<0.01

RL#	SPP	A/S	T	MOYR	CTY	ENDRN	KETO
673	DEM	ADM	W	0582	021	<.005	<.005
674	DEM	ADF	W	0582	021	<.005	<.005
675	DEM	ADF	B	0582	021	<.005	<.005
676	DEM	ADF	L	0582	021	<.005	<.005
677	DEM	ADM	W	0582	021	<.005	<.005
691	DEM	ADM	W	0582	025	<.005	<.005
707	DEM	ADM	W	0582	025	<.005	0.011
708	DEM	ADM	B	0582	025	<0.01	<0.01
709	DEM	ADM	L	0582	025	<0.01	00.04
713	DEM	ADF	W	0582	025	<.005	<.005
714	DEM	ADM	W	0582	025	<.005	<.005
715	DEM	ADM	B	0582	025	<0.01	<0.01
716	DEM	ADM	L	0582	025	<0.01	<0.01
692	DEM	SAF	W	0582	025	<.005	<.005
693	DEM	SAF	B	0582	025	<0.01	<0.01
694	DEM	SAF	L	0582	025	<0.01	<0.01
695	DEM	ADM	W	0582	025	<.005	0.006
710	DEM	ADF	W	0582	025	<.005	<.005
711	DEM	ADF	B	0582	025	<0.01	<0.01
712	DEM	ADF	L	0582	025	<0.01	<0.01
706	DEM	JVM	W	0582	025	<.005	<.005
231	DEM	SAF	W	0682	037	0.079	00.14
233	DEM	ADM	W	0682	037	00.18	00.33
234	DEM	SAM	W	0682	037	00.18	00.96
236	DEM	COM	B	0682	037	0.084	00.35
237	DEM	ADF	W	0682	037	0.007	00.04
238	DEM	ADF	W	0682	037	0.017	00.04
239	DEM	COB	B	0682	037	<.005	00.03
240	DEM	COB	L	0682	037	00.16	00.50
241	DEM	ADM	W	0682	037	0.013	00.19
242	DEM	ADF	W	0682	037	<.005	<0.02
243	DEM	COB	L	0682	037	0.042	00.57
244	DEM	COB	B	0682	037	<.005	00.03
293	DEM	ADF	W	0782	037	<.005	<0.02
294	DEM	ADF	L	0782	037	00.02	00.09
295	DEM	ADF	B	0782	037	<.005	<0.02
296	DEM	ADM	W	0782	037	<.005	00.05
297	DEM	ADM	B	0782	037	<.005	<0.02
298	DEM	ADM	L	0782	037	00.02	00.66
299	DEM	ADM	W	0782	065	<.005	00.03
300	DEM	ADM	B	0782	065	<.005	<0.02
301	DEM	ADM	L	0782	065	0.014	00.23
302	DEM	ADF	W	0782	065	<.005	00.03
303	DEM	ADF	L	0782	065	0.025	00.14
304	DEM	ADF	B	0782	065	<.005	00.02
305	DEM		V	0782	065	<.005	<0.02
363	DEM	ADF	W	0782	065	<.005	<.005

RL#	SPP	A/S	T	MOYR	CTY	ENDRN	KETO
364	DEM	ADF	B	0782	065	0.008	<.005
365	DEM	ADF	L	0782	065	0.014	0.019
366	DEM	ADM	W	0782	065	<.005	<.005
367	DEM	ADM	B	0782	065	<.005	<.005
368	DEM	ADM	L	0782	065	<.005	0.067
369	DEM	SAM	W	0782	065	<.005	0.011
459	DEM	ADM	W	0882	037	<.005	<.005
460	DEM	ADM	B	0882	037	<0.01	<0.01
461	DEM	ADM	L	0882	037	<0.01	00.12
462	DEM	ADF	W	0882	037	0.007	0.014
463	DEM	ADF	B	0882	037	<0.01	<0.01
464	DEM	ADF	L	0882	037	0.008	00.05
465	DEM	SAM	W	0882	037	<.005	0.011
466	DEM	SAM	B	0882	037	<0.01	<0.01
467	DEM	SAM	L	0882	037	<0.01	00.08
468	DEM	SAF	W	0882	037	<.005	0.015
469	DEM	SAF	B	0882	037	<0.01	00.04
470	DEM	SAF	L	0882	037	00.10	00.34

Count of SPP DEM = 159

218	ERG	ADF	F	0482	015	<0.01
219	ERG	ADM	F	0482	015	00.08
220	ERG	ADM	F	0482	015	00.21
221	ERG	ADF	F	0482	015	00.09
481	ERG	JVF	F	0982	067	<0.01

Count of SPP ERG = 5

E06	GAD		M	0981	067	0.004
E57	GAD	JVF	F	0981	015	00.06
088	GAD	JVF	F	1081	015	0.10
089	GAD	JVF	F	1081	015	00.28
090	GAD	JVF	F	1081	015	00.06
091	GAD	JVM	F	1081	015	00.09
097	GAD	JVF	F	1181	015	<0.01
100	GAD	JVF	F	1181	015	00.07
098	GAD	JVF	F	1181	015	00.08
099	GAD	JVF	F	1181	015	00.02
102	GAD	JVF	F	1181	015	00.06
223	GAD	ADM	F	0682	065	00.54
227	GAD	ADF	F	0682	065	00.65
225	GAD	ADF	F	0682	037	00.06

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RL#	SPP	A/S	T	MOYR	CTY	ENDRN	KETO
331	GAD	ADF	F	0782	037	00.76	
413	GAD	JV	F	0882	015	00.01	
415	GAD	ADF	F	0882	015	00.06	
419	GAD	JV	F	0882	015	00.02	
722	GAD		F	1082	071	<0.01	
489	GAD	JVF	F	1082	083	<0.01	
495	GAD	JVM	F	1082	083	<0.01	
498	GAD	ADM	F	1082	083	00.02	

Count of SPP GAD = 22

RL#	SPP	A/S	T	MOYR	CTY	ENDRN	KETO
141	GHO		F	1181	021	00.09	
140	GHO		F	1181	021	00.04	
143	GHO		F	1181	021	00.10	
145	GHO		F	1281	087	<0.01	
142	GHO		F	0182	021	00.01	

Count of SPP GHO = 5

RL#	SPP	A/S	T	MOYR	CTY	ENDRN	KETO
144	GOE		F	1181	065	<0.01	

Count of SPP GOE = 1

RL#	SPP	A/S	T	MOYR	CTY	ENDRN	KETO
029	GWT	JVM	F	1081	017	<0.01	
173	GWT	ADM	F	0482	015	00.01	
173	GWT	ADM	M	0482	015	<.005	
281	GWT	ADM	B	0482	015	<.005	
282	GWT	ADM	G	0482	015	<.005	
197	GWT	ADM	F	0582	021	<0.01	
479	GWT	ADM	F	0982	067	00.20	
491	GWT	JVM	F	1082	083	<0.01	

Count of SPP GWT = 8

RL#	SPP	A/S	T	MOYR	CTY	ENDRN	KETO
206	HAR	ADF	F	0582	021	00.33	
213	HAR		E	0582	021	<0.01	
508	HAR	JV	F	0882	017	00.07	
509	HAR	ADM	F	0882	017	00.04	
442	HAR	JVM	F	0982	065	00.17	

RL#	SPP	A/S	T	MOYR	CTY	ENDRN	KETO
443	HAR	JVM	F	0982	037	00.12	
444	HAR	JVM	C	0982	037	<0.01	

Count of SPP HAR = 7

RL#	SPP	A/S	T	MOYR	CTY	ENDRN	KETO
530	HSM	ADF	W	1181	015	0.032	<.005
531	HSM	ADF	B	1181	015	00.04	<0.01
532	HSM	ADF	L	1181	015	00.03	<0.01
529	HSM	ADF	W	1181	015	0.014	<.005
576	HSM	SAF	W	1181	025	<.005	<.005

Count of SPP HSM = 5

RL#	SPP	A/S	T	MOYR	CTY	ENDRN	KETO
018	HUP		F	1081	027	<0.01	
030	HUP		F	1081	027	<0.01	
118	HUP	ADF	F	1181	025	00.12	
192	HUP	ADF	F	0482	021	00.03	
194	HUP	ADM	F	0482	021	00.04	
334	HUP	ADM	F	0782	025	00.02	

Count of SPP HUP = 6

RL#	SPP	A/S	T	MOYR	CTY	ENDRN	KETO
574	HVM	ADF	W	1181	021	<.005	<.005
562	HVM	ADM	W	1181	021	<.005	<.005
563	HVM	ADM	W	1181	021	<.005	<.005
564	HVM	ADM	B	1181	021	<0.01	<0.01
565	HVM	ADM	L	1181	021	00.03	<0.01
582	HVM	SAM	W	1181	025	<.005	<.005
584	HVM	COF	B	1181	025	<0.01	<0.01
585	HVM	COF	L	1181	025	00.06	<0.01
583	HVM	SAF	W	1181	025	<.005	<.005
696	HVM	SAM	W	0582	025	<.005	0.009

Count of SPP HVM = 10

RL#	SPP	A/S	T	MOYR	CTY	ENDRN	KETO
207	KES	ADM	F	0482	021	<0.01	
306	KES	ADF	B	0782	067	<.005	

RL#	SPP	A/S	T	MOYR	CTY	ENDRN	KETO
Count of SPP KES =							2
610	LAL	JVM	W	1181	015	<.005	
Count of SPP LAL =							1
196	LEO	AD	F	0482	021	00.03	
208	LEO	ADF	F	0582	021	00.07	
211	LEO		E	0582	021	<0.01	
Count of SPP LEO =							3
739	LHS	AD	F	0582	021	<0.01	
740	LHS	AD	B	0582	021	<0.01	
Count of SPP LHS =							2
205	LOO	AD	F	0482	015	00.19	
Count of SPP LOO =							1
X11	MAL	ADM	X	0981	017	0.019	
X14	MAL	ADM	F	0981	025	<0.01	
E03	MAL	ADF	M	0981	067	<.001	
E59	MAL	JVM	F	0981	015	00.08	
017	MAL		F	1081	027	<0.01	
007	MAL	ADF	F	1081	021	00.06	
008	MAL	ADF	F	1081	021	00.02	
009	MAL	ADF	F	1081	021	00.01	
027	MAL	ADM	F	1081	017	00.02	
028	MAL	JVF	F	1081	017	00.01	
054	MAL	ADM	F	1081	025	<0.01	
055	MAL	ADM	F	1081	025	<0.01	
056	MAL	ADM	F	1081	025	<0.01	
057	MAL	ADF	F	1081	025	<0.01	
092	MAL	ADF	F	1181	025	<0.01	
093	MAL	ADM	F	1181	025	<0.01	
146	MAL	ADM	F	0282	015	<0.07	

RL#	SPP	A/S	T	MOYR	CTY	ENDRN	KETO
146	MAL	ADM	M	0282	015	<.005	
147	MAL	ADM	F	0282	015	<0.01	
198	MAL	ADM	F	0482	021	00.08	
198	MAL	ADM	M	0482	021	<.005	
200	MAL	ADF	F	0482	021	00.04	
171	MAL	ADM	F	0482	015	00.32	
171	MAL	ADM	M	0482	015	0.008	
273	MAL	ADM	B	0482	015	<.005	
274	MAL	ADM	G	0482	015	<.005	
210	MAL		E	0482	015	<0.01	
170	MAL	ADM	F	0482	015	<0.01	
152	MAL	ADM	F	0582	017	00.03	
153	MAL	ADM	F	0582	017	0.11	
154	MAL	ADM	F	0582	017	0.12	
162	MAL	ADM	F	0582	021	00.05	
165	MAL	ADM	F	0582	021	00.06	
189	MAL	ADF	F	0582	021	00.04	
191	MAL	ADF	F	0582	021	00.01	
212	MAL		E	0582	021	00.01	
168	MAL	ADM	F	0582	025	00.22	
336	MAL	ADM	F	0782	021	00.03	
333	MAL	ADF	F	0782	021	00.02	
351	MAL	ADF	F	0782	017	00.04	
403	MAL	JVM	F	0782	033	<0.01	
405	MAL	ADM	F	0782	033	<0.01	
505	MAL	ADF	F	0882	003	<0.01	
429	MAL	JVM	F	0882	025	<0.01	
424	MAL	JVF	F	0882	017	<0.01	
426	MAL	ADM	F	0882	017	00.03	
430	MAL	ADF	F	0882	017	00.03	
431	MAL	JVF	F	0882	017	00.02	
436	MAL	JVF	F	0982	065	00.01	
437	MAL	JVM	F	0982	065	00.01	
723	MAL	F	F	1082	071	<0.01	
490	MAL	JVM	F	1082	083	<0.01	
492	MAL	JVM	F	1082	083	<0.01	
493	MAL	ADM	F	1082	083	<0.01	
496	MAL	ADF	F	1082	083	00.63	
497	MAL	JVM	F	1082	083	00.04	
499	MAL	ADF	F	1082	083	00.03	
502	MAL	ADM	F	1082	083	00.04	
724	MAL	M	F	1082	071	<0.01	
725	MAL	M	F	1082	071	<0.01	
726	MAL		F	1082	071	<0.01	
727	MAL		F	1082	071	<0.01	
728	MAL		F	1082	071	<0.01	
729	MAL		F	1082	071	<0.01	

Wildlife Tissue Sample Results

RL#	SPP	A/S	T	MOYR	CTY	ENDRN	KETO
732	MAL	F	F	1082	071	<0.01	

Count of SPP MAL = 65

RL#	SPP	A/S	T	MOYR	CTY	ENDRN	KETO
683	MCL	ADM	W	0482	015	0.027	
684	MCL	ADM	B	0482	015	<0.01	
682	MCL	ADF	W	0482	015	0.013	
776	MCL	ADF	W	0982	065	<.005	
777	MCL	ADF	W	0982	065	<.005	
778	MCL	ADF	B	0982	065	<0.01	
779	MCL	ADF	F	0982	065	<0.01	
787	MCL	ADM	W	0982	065	<.005	
788	MCL	JVM	W	0982	065	<.005	
789	MCL	COM	B	0982	065	<0.01	
790	MCL	COM	F	0982	065	00.08	

Count of SPP MCL = 11

RL#	SPP	A/S	T	MOYR	CTY	ENDRN	KETO
685	MDL	ADM	F	0482	015	00.02	
686	MDL	ADM	B	0482	015	<0.01	
734	MDL	ADF	F	0582	021	00.01	
735	MDL	ADF	B	0582	021	<0.01	
781	MDL	JVM	F	0982	037	<0.01	
782	MDL	JVM	B	0982	037	<0.01	
784	MDL	JVF	F	0982	065	<0.01	
785	MDL	JVF	B	0982	065	<0.01	

Count of SPP MDL = 8

RL#	SPP	A/S	T	MOYR	CTY	ENDRN	KETO
534	MDV	ADM	W	1181	015	<.005	<.005
535	MDV	ADM	B	1181	015	<0.01	<0.01
536	MDV	ADM	L	1181	015	<0.01	00.01
538	MDV	COF	B	1181	015	<0.01	<0.01
539	MDV	COF	L	1181	015	<.005	<.005
548	MDV	SAF	W	1181	021	<.005	<.005
561	MDV	ADM	W	1181	021	<.005	<.005
577	MDV	SAF	W	1181	025	<.005	<.005
537	MDV	ADF	W	LL81	015	<.005	0.009
625	MDV	ADF	W	0482	015	<.005	<.005
626	MDV	ADF	B	0482	015	<0.01	<0.01
627	MDV	ADF	L	0482	015	<.005	<.005

RL#	SPP	A/S	T	MOYR	CTY	ENDRN	KETO
641	MDV	ADM	W	0482	015	<.005	<.005
642	MDV	ADM	B	0482	015	<0.01	<0.01
643	MDV	ADM	L	0482	015	<.005	<.005
648	MDV	ADF	W	0482	015	0.013	<.005
649	MDV	SAF	W	0482	015	0.029	<.005
650	MDV	ADM	W	0482	015	<.005	<.005
651	MDV	ADM	B	0482	015	<0.01	<0.01
652	MDV	ADM	L	0482	015	0.029	<.005
678	MDV	ADF	W	0582	021	<.005	<.005

Count of SPP MDV = 21

RL#	SPP	A/S	T	MOYR	CTY	ENDRN	KETO
X15	MLD	ADF	F	0881	079	<0.01	
335	MLD	ADM	F	0782	083	<0.01	

Count of SPP MLD = 2

RL#	SPP	A/S	T	MOYR	CTY	ENDRN	KETO
181	MMT	ADM	L	0482	075	<0.01	

Count of SPP MMT = 1

RL#	SPP	A/S	T	MOYR	CTY	ENDRN	KETO
X02	MOD		F	0881	075	00.09	
X02	MOD		M	0881	075	0.003	
736	MOD	ADF	F	0582	021	<0.01	
763	MOD	ADM	F	0582	025	00.17	
764	MOD	ADM	B	0582	025	<0.01	
325	MOD	ADF	F	0782	083	<0.01	
434	MOD	CO	F	0882	017	<0.01	

Count of SPP MOD = 7

RL#	SPP	A/S	T	MOYR	CTY	ENDRN	KETO
608	PHL	ADM	B	1181	015	<0.01	
609	PHL	ADM	F	1181	015	00.16	
604	PHL	ADF	W	1181	015	<.005	
605	PHL	ADF	B	1181	015	<0.01	
606	PHL	ADF	F	1181	015	00.06	
607	PHL	ADM	W	1181	015	0.011	
667	PHL	ADM	W	0482	015	<.005	
668	PHL	ADM	B	0482	015	00.02	

RL#	SPP	A/S	T	MOYR	CTY	ENDRN	KETO
662	PHL	ADF	W	0482	015	<.005	
663	PHL	ADF	W	0482	015	0.016	
664	PHL	ADF	B	0482	015	<0.01	
665	PHL	ADF	F	0482	015	00.14	
666	PHL	ADM	W	0482	015	0.010	
699	PHL	ADF	W	0582	021	<.005	
741	PHL	ADM	W	0582	021	<.005	
765	PHL	ADM	W	0582	025	0.008	
768	PHL	ADF	F	0582	025	00.10	
769	PHL	ADF	B	0582	025	<0.01	
209	PHL		E	0582	025	<0.01	
767	PHL	ADF	W	0582	025	0.006	
760	PHL	ADF	W	0582	025	<.005	
761	PHL	ADF	F	0582	025	00.05	
245	PHL	ADM	W	0582	065	<.005	
246	PHL	ADF	W	0582	065	<.005	
247	PHL	ADM	B	0582	065	<.005	
248	PHL	ADB	F	0582	065	<0.01	
232	PHL	ADM	W	0682	037	<.005	
249	PHL	ADM	W	0682	065	00.22	
250	PHL	ADM	W	0682	065	00.07	
251	PHL	ADF	W	0682	065	00.15	
252	PHL	ADF	W	0682	065	0.065	
253	PHL	ADM	B	0682	065	00.19	
254	PHL	ADB	F	0682	065	03.57	
255	PHL	ADF	B	0682	065	<.005	
256	PHL	ADM	W	0682	065	00.11	
257	PHL	ADM	W	0682	065	00.21	
258	PHL	ADM	F	0682	065	03.03	
259	PHL	ADM	B	0682	065	00.16	
260	PHL	ADF	W	0682	065	00.14	
261	PHL	ADF	W	0682	065	00.20	
262	PHL	ADF	F	0682	065	01.74	
263	PHL	ADF	B	0682	065	00.04	
264	PHL	ADF	E	0682	065	01.10	
269	PHL	ADF	W	0782	065	0.066	
270	PHL	ADM	W	0782	065	0.030	
271	PHL	ADB	F	0782	065	00.61	
272	PHL	ADB	B	0782	065	0.008	
284	PHL	ADF	W	0782	065	00.03	
285	PHL	ADF	F	0782	065	00.49	
286	PHL		E	0782	065	00.15	
287	PHL	ADM	W	0782	065	<.005	
288	PHL	ADM	F	0782	065	00.23	
289	PHL	ADM	B	0782	065	0.007	
471	PHL	ADF	W	0782	065	00.01	
407	PHL	ADM	W	0782	065	0.021	

RL#	SPP	A/S	T	MOYR	CTY	ENDRN	KETO
770	PHL	ADF	W	0782	065	0.021	
771	PHL	ADM	W	0782	065	<.005	
772	PHL	ADM	F	0782	065	00.10	
773	PHL	ADM	B	0782	065	<.005	
774	PHL	JVF	W	0782	065	<.005	
775	PHL	JVF	B	0782	065	<0.01	
370	PHL	ADM	W	0782	065	<.005	
371	PHL	ADM	F	0782	065	00.09	
372	PHL	ADM	B	0782	065	0.006	
373	PHL	ADF	W	0782	065	0.006	
374	PHL	JV	W	0782	065	<.005	
375	PHL	COB	F	0782	065	<0.01	
376	PHL	COB	B	0782	065	<.005	
392	PHL	ADM	W	0782	065	<.005	
393	PHL	ADM	F	0782	065	00.04	
394	PHL	ADM	B	0782	065	<.005	
395	PHL	JVM	W	0782	065	0.007	
396	PHL	JVM	F	0782	065	<0.01	
397	PHL	JVM	B	0782	065	0.038	
356	PHL	ADM	W	0782	065	<0.01	
357	PHL	ADM	F	0782	065	<0.01	
358	PHL	ADM	B	0782	065	<.005	
359	PHL	ADF	W	0782	065	<.005	
360	PHL	JVM	W	0782	065	<.005	
361	PHL	COB	F	0782	065	<0.01	
362	PHL	COB	B	0782	065	<.005	
483	PHL	JV	W	0882	065	<.005	
484	PHL	ADF	W	0882	065	<.005	
485	PHL	ADF	F	0882	065	00.02	
486	PHL	ADF	B	0882	065	<0.01	
516	PHL	ADM	W	0882	065	<.005	
517	PHL	ADM	F	0882	065	00.01	
518	PHL	ADM	B	0882	065	<0.01	
783	PHL	ADM	W	0982	065	<.005	

Count of SPP PHL = 89

RL#	SPP	A/S	T	MOYR	CTY	ENDRN	KETO
106	PHT	JVF	F	1181	021	00.04	
107	PHT	JVF	F	1181	021	00.07	
108	PHT	JVF	F	1181	021	00.06	
109	PHT	JVM	F	1181	021	00.03	
137	PHT	JVM	F	1281	025	00.16	
138	PHT	JVM	F	1281	025	00.11	
199	PHT	ADM	F	0482	025	00.08	
202	PHT	ADM	F	0482	025	<0.01	

Wildlife Tissue Sample Results

RL#	SPP	A/S	T	MOYR	CTY	ENDRN	KETO
076	WTD	FNM	B	0981	075	<0.01	
126	WTD	02M	F	1181	017	<0.01	
127	WTD	03M	F	1181	017	<0.01	
176	WTD	M	F	1181	025	<0.01	
324	WTD	ADF	F	0682	021	<0.01	
Count of SPP WTD =							5
159	WTJ	ADM	F	0482	021	<0.01	
158	WTJ	ADF	F	0582	021	<0.01	
382	WTJ	ADF	F	0782	065	0.029	<.005
383	WTJ	ADF	L	0782	065	0.068	<.005
384	WTJ	ADF	B	0782	065	0.006	<.005
385	WTJ	ADM	F	0782	065	00.01	
386	WTJ	ADM	B	0782	065	<.005	
387	WTJ	ADM	L	0782	065	0.047	
388	WTJ	ADF	F	0782	065	<0.01	
389	WTJ	ADF	B	0782	065	<.005	
390	WTJ	ADF	L	0782	065	0.092	
Count of SPP WTJ =							11
687	YRW	AD	W	0582	021	<.005	
Count of SPP YRW =							1

KEY TO THE WILDLIFE RESULTS

Column Headings:

RL# = Research Lab Number
SPP = Species
AG = Age
S = Sex
T = Tissue Samples
MO = Month
YR = Year
CTY = County
ENDRIN = Endrin
KETO = Keto endrin

Species:

Upland Game Birds:
BLG = Blue Grouse
CHP = Chukar Partridge
HUP = Hungarian Partridge
MMT = Merriam Turkey
MOD = Mourning Dove
PHT = Pheasant
SAG = Sage Grouse
STG = Sharp-tailed Grouse

Geese:
CNG = Canada Goose
DMG = Domestic Goose

Ducks:
BDP = Baldpate (Widgeon)
BFH = Bufflehead
BWT = Blue-winged Teal
CNT = Cinnamon Teal
COT = Coot
CVB = Canvasback
BRG = Bared Grebe
CAD = Gadwall
GFY = American Goldeheye
GWT = Green-winged Teal
LOO = Common Loon
MAL = Mallard
PTL = Pintail
RHD = Redhead Duck
RND = Ringneck Duck
RUD = Ruddy Duck
SHV = Shoveler
SCP = Lesser Scaup

Big Game:
ANT = Antelope
BLD = Black Bear
MLD = Mule Deer
WTD = White-tailed Deer

Mammals:
BAD = Badger
BPD = Black-tailed Prairie Dog
COY = Coyote
CTR = Cottontail Rabbit
DEM = Deer Mouse
HSM = House Mouse
HVM = Harvest Mouse
MDV = Meadow Vole
PKM = Pocket Mouse
POR = Porcupine
RFX = Red Fox
SSK = Striped Skunk
TGS = Thirteen-lined Ground Squirrel
WPD = White-tailed Prairie Dog
WTJ = White-tailed Jackrabbit

Raptors:
GHO = Great Horned Owl
HAR = Harrier (March Hawk)
KES = Kestrel (Sparrow Hawk)
LEO = Long-eared Owl
RTH = Red-tailed Hawk
SEO = Short-eared Owl
TUR = Turkey Vulture

Other Birds:
CSW = Cliff Swallow
CCL = Chestnut collared Longspur
CWB = Cowbird
LAL = Lapland Longspur
LHS = Loggerhead Shrike
MCL = McCown's Longspur
MDL = Meadow Lark
PHL = Prairie Horned Lark
RWB = Red-winged Blackbird
SNB = Snow Bunting
VSS = Vesper Sparrow
WCS = White Crowned Sparrow
YRW = Yellow-rumped Warbler

Additional Species:
SNL = Snails
CUT = Cutworms

Age:
A = Adult
F = Fawn
I = Immature
J = Juvenile
S = Subadult
U = Unknown
Y = Yearling
C = Combination of 1 or more of the above

Tissue:

F	=	Fat
B	=	Brain
L	=	Liver
W	=	Whole (or Whole Body)
M	=	Meat
C	=	Crop Contents
G	=	Gizzard Contents
E	=	Eggs
S	=	Sediment (mud)
D	=	Drippings
X	=	Cooked Meat
Y	=	Food
Z	=	Wheat
H	=	Water
U	=	Wheat Chaff

County Codes are:

001	Beaverhead	057	Madison
003	Big Horn	059	Meagher
005	Blaine	061	Mineral
007	Broadwater	063	Missoula
009	Carbon	065	Musselshell
011	Carter	067	Park
013	Cascade	069	Petroleum
015	Chouteau	071	Phillips
017	Custer	073	Pondera
019	Daniels	075	Powder River
021	Dawson	077	Powell
025	Deer Lodge	079	Prairie
026	Fallon	081	Ravalli
027	Fergus	083	Richland
029	Flathead	085	Roosevelt
031	Gallatin	087	Rosebud
033	Garfield	089	Sanders
036	Glacier	091	Sheridan
037	Golden Valley	093	Silver Bow
039	Granite	095	Stillwater
041	Hill	097	Sweet Grass
043	Jefferson	099	Teton
045	Judith Basin	101	Toole
047	Lake	103	Treasure
049	Lewis & Clark	105	Valley
051	Liberty	107	Wheatland
053	Lincoln	109	Wibaux
055	McCone	111	Yellowstone

Appendix IV.

Current Endrin Rules

Sub-Chapter 9

New Rules of Endrin

4.10.901 SALE AND USE OF ENDRIN FOR PALE WESTERN AND ARMY CUTWORM CONTROL (1) The application of products containing the chemical endrin shall only be allowed for the control of army cutworm and pale western cutworm and only on small grain crops.

(2) Subsections (2), (3) and (4) of Rule II as originally proposed (re-printed below) are withheld from this adoption pending further study through an Environmental Impact Statement under Title 75, Chapter 1 MCA (Montana Environmental Policy Act).

> (2) The use of products containing the chemical endrin for the purpose of controlling army cutworm and pale western cutworm in small grains is prohibited in any county of the State of Montana until qualified state or university personnel approved by the department determine by field survey that an infestation of either pest exists within the county and there are no effective or available alternate control methods. The field survey personnel and the director will consider information such as: ambient temperature, soil temperature, soil type, soil moisture, crop height and density, and insect density in the decision making process. The director, after reviewing the recommendation of these personnel, will make the final use decision for each county. The department will, through mass media and appropriate government agencies, inform applicators, dealers and agricultural producers of those counties in which endrin may be used, special application precautions, and information on determining economic thresholds and conducting field surveys.
>
> (3) Products containing the chemical endrin for use on small grains shall be sold only to licensed, certified commercial or government applicators. Use of endrin is restricted to commercial and government applicators.
>
> (4) Application of endrin is prohibited within (¼) mile of any permanent lake, pond, river, stream, irrigation system, or semi permanent bodies of water, whether public or private.

(3) Farm applicators shall notify the department by telephone or correspondence within one (1) week of any application of endrin and provide the following information: their name, address, telephone number and the acreage sprayed. (History: Sec. 80-8-105 MCA; IMP, Sec. 80-8-105 MCA; NEW, 1982 MAR p. 560; Eff. 3/26/82.)

4.10.902 VIOLATION (1) It shall be a violation for any person to:

(a) use endrin inconsistent with its label or labeling or the provisions of the rules in this sub chapter;

(b) fail to comply with any requirements or conditions of this sub chapter. (History: Sec. 80-8-105 MCA; IMP, Sec. 80-8-105 MCA; NEW, 1982 MAR p. 560; Eff 3/26/82.)

Appendix V.

Proposed Endrin Rule

Appendix V.

PROPOSED NEW RULE - ENDRIN

(1) Based on a finding that alternatives to endrin are available, the right to sell or otherwise distribute, purchase or use endrin for use on small grains to control army and pale western cutworms in the state of Montana, except as provided below, is suspended on the effective date of this rule.

(2) Any existing stock for the registered use stated in No. 1 above purchased by and in the possession of a certified commercial or farm applicator on or before __________ 1983, may be applied only under the following conditions:

(a) That such use shall terminate no later than two (2) years from the effective date of this rule;

(b) That all such use shall strictly conform to the label requirements;

(c) That no aerial application shall be made within 1/4 mile, and no ground application shall be made within 1/8 mile of any lake, pond, river, stream, or irrigation system, whether public or private;

(d) That any intended use shall be reported by telephone or in writing by the applicator to the department prior to application, giving the following information:

(i) name of landowner;
(ii) name of applicator;
(iii) where the application will be made;
(iv) when the application will be made;
(v) number of acres to be treated.

In addition, certified commercial applicators shall make those post application reports as required by existing department rules.

(e) That at the end of the two (2) year period, any remaining stock shall be disposed of according to procedures established in the Pesticide Act and rules, and Hazardous Waste Act and its rules promulgated by the Department of Health and Environmental Sciences or returned to the manufacturer.

(3) Except as specified in No. 2 above, any other existing stock, including that held by dealers, shall be returned to the manufacturer or disposed of in accordance with (2) (e) above, no later than ____ days from the effective date of this rule.

(4) At such time as one or more of the alternatives to endrin, (now available through Sec. 18 FIFRA exemptions to registration) become registered by the EPA and the State of Montana, then the registration of endrin for purposes specified above shall be automatically cancelled. Existing stock may be used as specified in No. 2 above, if within the original two year period.

(5) If during the period of this suspension at least one alternative does not remain available under the Sec. 18 or the registration process, then the sale and use suspension, or registration cancellation, shall be automatically vacated and the right to sale and use shall be reinstated with the same restrictions for use of existing stock as provided in this rule, and such other restrictions as the department may further promulgate by rule.

(6) For purposes of this rule, availability determinations for alternatives shall be based on the following:

(a) Section 18 exemptions, or EPA registrations;

(b) Efficacy of the compound for cutworm control;

(7) The cancellation of registration of endrin for grasshopper control, effective 3/31/82, is hereby continued.

(8) The registration of endrin for control of meadow voles in apple orchards is hereby cancelled.

Appendix VI.

Gallons of Endrin Purchased and Acreage Treated by Commercial Applicators in 1981 and 1982

1981 Endrin Sales and Applications

	Gallons	Acres
Big Horn	120.3	770
Broadwater	54.2	347
Carbon	153.3	961
Carter	557.7	3,569
Cascade	685.5	4,387
Chouteau	1,025.2	6,560.8
Custer	3,661.3	23,432.5
Dawson	1,447.5	9,264
Fallon	2,328.3	13,901
Gallatin	12	63
Golden Valley	41.7	267
Judith Basin	168	1,075
Liberty	91.4	585
McCone	402	2,573
Park	76.30	488
Pondera	54.7	350
Powder River	1,853.9	11,865
Prairie	1,761.1	11,270
Richland	84.4	540
Rosebud	379.4	2,428
Stillwater	51.6	330
Teton	227	1,453
Treasure	46.1	295
Wibaux	102.7	657
Yellowstone	14.1	90
TOTAL	15,399.7	98,522.3

1982 Endrin, Chlorpyrifos and Permethrin Sales and Applications

County	Gallons	Acres Treated
Endrin		
Cascade	126	1,956
Golden Valley	675	5,400
Lewis & Clark	60	480
Judith Basin	26.25	210
Teton	60	480
Yellowstone	286	2,290
TOTAL	1,233.25	10,816
Chlorpyrifos (Lorsban)		
Cascade	237.65	950.2
Golden Valley	508.5	2,034
Wheatland	5	3,024.2
TOTAL	751.15	3,024.2
Permethrin (Ambush)		
Golden Valley	74.1	1,481
Big Horn	14	280
Cascade	4	80
TOTAL	92.1	1,841
Permethrin (Pounce)		
Golden Valley	81.9	2,621

GLOSSARY

Terms and Phrases Defined in the Context of this EIS.

Absorb - to take in and assimilate.

Acceptable Daily Intake (ADI) - the daily dosage of a chemical, which, during an entire lifetime, appears to be without appreciable risk on the basis of all the facts known at the time. ADI is expressed in milligrams of the chemical, as it appears in food, per kilogram of body weight (mg/kg/day).

Action Level - the Food and Drug Administration (FDA) and U.S. Department of Agriculture (USDA) administrative policy established to deal with chemicals on foods for which no tolerance has been set. These action levels apply to inadvertent residues at a specific level (ppm) for which either agency may take enforcement action removing the food commodity from the marketplace. Existence of these administrative action levels does not prevent legal action on lower residue levels if there is evidence of misuse of pesticides, or some other factor appears to warrant action.

Active Ingredient - an ingredient within a pesticide formlation which will prevent, destroy, repel, or mitigate any pest.

Acute Exposure - a severe single exposure, of short duration, to a chemical.

Acute Mortality - death caused by a single exposure. Exposure can be dermal (skin absorption), oral, or by inhalation.

Acute Toxicity - the property of a substance or mixture of substances to cause adverse effects in an organism through a single short term exposure.

Adsorb - to collect on a surface.

Bioaccumulate, (Biological Magnification or Bioconcentrate) - the phenomenon by which the concentration of a chemical is increased through successive steps of a food chain (flora and/or fauna) (trophic concentration); or biological concentration - the absorption of a chemical from the environment by filtering; or a combination of trophic and biological concentration resulting in increasing levels of chemical through the food chain.

Buffer Zone - a neutral area designated by labeling or administrative rule separating the application of a pesticide from an environmental sensitive site (water, homes, etc.) usually designed in feet or yards.

Carbamate - a generic term which includes the insecticides based upon carbamic acid (contains nitrogen).

Carcinogen - a substance or agent producing or inciting cancer.

Chlorinated Hydrocarbon - see organochlorines.

Chronic Exposure - repeated exposure over an extended period of time.

Chronic Toxicity - the property of a substance or mixture of substances to cause adverse effects in an organism upon repeated or continuous exposure over a period of at least 1/2 the lifetime of that organism.

Commercial/Government Applicator - an applicator licensed and/or certified to use general or restricted use pesticides by the Montana Department of Agriculture.

Degradation - conversion of an organic compound into a simpler compound by removal of one or more parts of its molecule.

Dermal - pertaining to skin.

Efficacy, Efficacious - the capacity of a pesticide product when used according to label directions to control, kill, or induce a desired action in the target pest.

Environment - the characteristics and combinations of all internal and external conditions that influence the existence, growth, welfare of organisms; includes physical media such as water, air, soil; all living organisms; and their interrelationships.

Environmental Impact Statement (EIS) - the detailed written statement prepared pursuant to section 75-1-201, MCA, (draft or final) which assess the environmental impact of a proposed action.

Farm (Private) Applicator - an applicator certified by the Montana Department of Agriculture to use restricted use pesticides on their own property.

FIFRA - the Federal Insecticide, Fungicide, and Rodenticide Act, as amended, by the Federal Environmental Pesticide Control Act of 1972 and other legislation supplementary thereto and amendatory thereof, administered by EPA to regulate the sale and use of pesticides.

Federal Registration - a process by which a substance is registered as a pesticide under FIFRA, as amended, after a thorough review of environmental and health criteria and standards.

Fetotoxic - any substance or mixture of substances that produces or induces a complete range of deforming or nondeforming injury during the fetal period, ranging from retardation of growth to

visible injury to organs to increased mortality during any part of development.

Food Chain - an arrangement of the organisms (flora and/or fauna) of an ecological community according to the order of consumption or predation in which each uses the next lower member as a food source.

Half Life - the time necessary to degrade or reduce by half the concentration of a compound in the environment or in an organism in the absence of further introduction or intake.

Hazard - likelihood that use of a substance would result in an adverse effect on man or the environment in a given situation.

Impact - (as used in this EIS) the detrimental (adverse) or beneficial effect(s) on the biological, physical, social, or economic factors that interrelate to form the environment.

Keto-endrin - metabolic by-product of endrin.

LD_{50} - an estimate of the dosage that will kill one half of a population of test animals; usually measured in milligrams of substance per kilogram of animal body weight (mg/kg).

Leach - a process by which a substance in the soil is displaced, usually by water, to another location.

Metabolize - the physical and chemical processes by which materials (chemicals) are assimilated, broken down to produce energy, or enter into biological processes within an organism.

Montana Administrative Procedure Act (MAPA) - Title 2, Chapter 4, MCA; establishes procedures which executive branch agencies must follow when executing their rule making and other regulatory functions.

Montana Environmental Policy Act (MEPA) - Title 75, Chapter 1, MCA; declares the intent of the legislature in creating a policy for harmonizing man and his environment, and establishing procedures (EIS) which the state must follow to achieve that harmony.

Mutagen - any substance or mixture of substances that induces changes in the genetic complement of either somatic or germinal tissue in subsequent generations.

No Tolerance - a tolerance has not been established for a chemical in or on a food commodity by EPA (no chemical residue allowed).

Oncogen - any substance or mixture of substances that produces or induces benign or malignant tumor formations in living animals.

Organochlorine - a generic term which includes the organic insecticides containing chlorine.

Organophosphate - a generic term which includes the organic insecticides containing phosphorus.

Oviposition - the act or process of laying or depositing eggs by insects.

Parts Per Million (ppm) - the number of parts by weight or volume of a substance in 1,000,000 parts of the final mixture (1 ppm is one unit of a substance by weight or volume compared to 1,000,000 units of the final mixture).
Examples:
1 ppm = 1 milligram of a pesticide per kilogram of tissue (1 mg/kg).
1 milligram of a pesticide per liter of water (1 mg/l).

Persistent - the property of a substance or mixture of substances and its metabolites to remain in the environment over an extended period of time.

Preliminary Environmental Review (PER) - a brief written statement on a proposed agency action to determine whether the action will significantly affect the quality of the human environment and therefore requires a draft environmental impact statement.

Residue - the pesticide and its metabolites or degradation products that can be detected in the crops, soil, water or other components of the environment, including man, following its use.

Restricted Use Pesticide - any pesticide, including highly toxic pesticides, which have been found to be injurious when used in accordance with registration, label, directions, and cautions to persons, beneficial insects, animals, crops, or the environment other than the pests it is intended to prevent, destroy, control, or mitigate.

Sale - to sell, wholesale, offer or expose for sale, exchange, barter or give away a pesticide.

Section 18 - a special registration (specific exemption) granted by EPA to federal or state agencies for emergency use of a pesticide not registered for a particular site and/or pest under FIFRA, as amended.

Specific Exemption - see definition of Section 18.

State Registration - a process by which a pesticide is registered under the Montana Pesticide Act.

Subacute Toxicity - the property of a substance or mixture of substances to cause adverse effects in an organism upon repeated

or continuous exposure within less than 1/2 the lifetime of that organism.

Teratogen - any substance or mixture of substances that produces or induces functional deviations or developmental abnormalities, not heritable, in or on an animal embryo or fetus.

Toxic - poisonous.

Tolerance - specifies the level of a contaminant in food or commodities, above which will render the food or commodity adulterated and subject to FDA or USDA legal action.

Toxicity - the property of a substance or mixture of substances to cause any adverse physiological effects.

Trophic Level - one of the levels of a food web (chain) characterized by the same general type of organisms - primary producers, primary consumers, secondary consumers and decomposers.

Use - any act of handling, application, mixing, loading, storage, disposal, or release of a pesticide or exposure of man or the environment to a pesticide.

Zero Tolerance - a tolerance that has been specified as zero, that is, no amount of the pesticide may remain on the raw agricultural commodity when it enters the marketplace.

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